THE CASE AGAINST THE STONE-TIPPED ARROW IN THE EAST AFRICAN POST-PLEISTOCENE

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ABSTRACT

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By

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This study undertook to examine the assumptions and evidence behind the traditional interpretation of geometric microliths from the Post-Pleistocene period in East Africa as inset barbs in composite arrows made of wood, gum resin, and stone. On the basis of extensive data taken on morphology, dimensions and damage due to manufacture, use and abuse, the validity of the conventional interpretation was rejected. The evidence gathered for this study, when taken together with existing evidence, strongly suggests a range of camp activities as possible functions for these tools.

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INTRODUCTION

The original concept of this study focused on the prospect of observing and recording microscopic traces of utilization. The artefact sample used in this analysis was part of a collection from a rock shelter in Uganda in East Africa which was characterized by those associated with the excavation as a Wilton-type, possibly quite recent, Later Stone Age microlithic assemblage. This assemblage was assumed to represent a nomadic, hunting and gathering way of life. The lithic technology was assumed to be predicated upon composite tools of wood or bone with tiny stone insets. Hunting strategies were assumed to be oriented primarily to pursuit of large game with bows and composite arrows. One component of the microlithic assemblage, namely those pieces called geometrics, were presumed, in accordance with traditional conclusions, to function directly in this activity as the barbs of the composite arrows. The perspective on this analysis was that it would be interesting to see what traces of these activities, if any, remained on the tools. However, the process of relating observed wear to presumed mode of use revealed such glaring inconsistencies that, in time, it was necessary to reexamine all the assumptions and concepts about artefact form, function, technology and economic strategies. As assumptions were found lacking or unsubstantiated, the study progressively became more and more exploratory, and in the end, microwear was only one of several kinds of evidence used to elucidate the functions and modes of use of geometric microliths.

CHAPTER I

REVIEW OF PRIMARY ASSUMPTIONS AND CONCEPTS

Chronological ordering

Traditional approaches to East African prehistoric material have focused upon typology and chronology. This is consistent of course with research objectives in the Old World in general, that is, to describe prehistoric "cultures" in terms of distinctive constallations of artefacts and order them properly in time (Bordes 1968). Thus, the plateau grasslands and forests of the eastern half of the African continent have been regarded as culturally homogeneous (Nelson 1971) through time. There are handaxe cultures, Fauresmith cultures and Wilton cultures from the Horn to the Cape. The African past was thought to conform to a Paleolithic-Mesolithic-Neolithic evolutionary model, and a taxonomic scheme, developed on the basis of South African material, was generalized to cover all of East Africa. In this scheme, the appearance of two primary elements, microlithic scrapers and "crescents," marked the beginning of the Mesolithic. Later this essentially European time-frame was abandoned in favor of a Stone Age/Iron Age dichotomy somewhat better suited to the African material. The Stone Age was subdivided into "Earlier, Middle, and Later" periods with the Later Stone Age corresponding roughtly to the Post-Pleistocene and characterized by microlithic industries collectively called "Wilton" after the type site in South Africa.

The Wilton culture concept

Post-Pleistocene microlithic industries have been characterized since the 1930s as "East African Wilton" on the basis of work and interpretation of L. S. B. Leakey (1931), T. P. O'Brien (1939), E. J. Wayland and M. C. Burkitt (1932), and others (see also Nelson 1970 for further discussion of early work). Now the validity of the term "Wilton" (Nelson 1971) and even the concept of a "Later Stone Age" (Clark _et al_ 1966) has been questioned. Accumulating data have demonstrated such a degree of variation that few today are willing to go much further than "Wilton-type" by way of classification of site materials. Although many authors continue to speak of "Wilton" or "Wilton-like" material, this is done with stated reservations (Sutton 1966).

The traditional assumptions about Post-Pleistocene cultural homogeneity of the eastern half of Africa were examined by Nelson (1971) specifically because of the increasing documentation of high variability in artefact frequency from site to site and region to region. Additionally, a very complex record of environment and resource exploitation is emerging in certain areas (see discussion in Deacon, H. 1972). Variability is so great that Nelson, for example, is unwilling to define "cultural" boundaries much more than a few hundred kilometers in areal extent. Sutton's (1966) handling of Later Stone Age assemblages from the Kenya highlands (which he sees as varying in aspect between a "Wilton look" with microliths predominating and the localized occurances of Kenya Capsian with long blades and burins) also seems to be a response to the increasing perception of local variability.

Others acknowledge the unsuitability of the Wilton label (for example, Gabel (1969)), but there is as yet no widely accepted substitute. It seems clear that it may in fact not be possible to continue using terms with cultural implications to describe large geographic areas of Africa.

Microlith technology

Chipped stone tools during the Post-Pleistocene are overwhelmingly microlithic in much of Africa. These small implements were made on blades, pieces of blades, or small flakes and were often carefully retouched into geometric shapes -- crescents, semi-circles, triangles, and trapeziforms. Although microlithic technologies are generally associated with the Post-Pleistocene period, the earliest occurrences fall well within the Late Pleistocene. Microlithic tools begin to appear in sub-Saharan Africa perhaps as much as 17,000 years ago in the wooded savannas of Zambia and Malawi where they are part of a complex called Nachikufan (C^{14} dates reported in Sampson and Southard 1973; Clark 1970).

The initial appearance of microliths in a region is generally marked as a technological advance to the composite-stone-tools-stage of development. Depending upon the area of the Old World involved, this stage may be called the Mesolithic, the Epipaleolithic, or Later Stone Age. Having already assumed that these "composite tools" simply represent analogous extensions of previous forms, prehistorians have explained the transition by additional ascertions about the advantages of these multicomponent tool forms. G. Clark (1971) links the shift to faunal and environmental changes and concommitant changes in hunting strategies, but does not explain the nature of this link. Semenov (1964) believes that people were more mobile after the retreat of the ice and had to make use of smaller pieces of raw material, and also that multicomponent tools represented distinct advantages for hunting in that the length of the cutting edge could be increased dramatically (his p. 63). However, it is not clear from his discussion why this should constitute an advantage or why the retreat of the ice produced this effect, especially in Africa. The commonest rationalization for transitions to microliths seem to be based upon an equation of increased complexity with technological advance -- a "more-is better" argument. These are not new tools but somehow better ways of making the same tools. Microliths have been correlated with Post-Pleistocene climatic and environmental changes (though they are now known to predate these), with reduced supplies of raw material (hardly a factor in East Africa), but expecially with the inferred invention of the bow and arrow.

Many other problems of interpretation are associated with the transition to these small forms. For example, the advantage of extreme smallness is unclear, although quite a few explanations have been offered. The forms themselves are not simply smaller editions of previous implements. They represent innovation, new technological responses without previous morphological analogs. Equally as important as these questions about evolution and transition (and linked to them) is the unsolved problem of using these artefacts to say something specific about the technology, economy, subsistence and "culture" of the groups which left them behind. Questions of this nature are new for African material and attempting to answer them has raised doubts concerning long accepted conclusions about microlith function (H. Deacon 1972; Phillipson 1969; Fagan and van Noten 1971).

Function aside for the moment, it was small size that led early prehistorians to assume that these tools were hafted -- that is, either mounted in a slotted wood, bone, ivory or antler "handle" with some natural gum or resin or, at least, in a lump of the mastic itself. However, evidence for this hafting is very seldom direct. Leakey's evidence consisted of crescents found in positions in the earth which suggested to him the linear arrangment of harpoon-like barbs (1931, p. 105). He concluded that stone crescents must have been set in slots with some sort of natural gum. Leakey's evidence may seem tenuous and poorly documented today, but the notion that geometric microliths, especially crescents, functioned as arrow barbs continued to be accepted without much examination or qualification by most archeologists working with sub-Saharan microlithic material (see for example Gabel 1965, p.4 and Semenov 1964, p. 63).

In 1958, Clark summarized much archeological and ethnographic evidence for the probable use and hafting of larger scrapers and adzes. He generalized from these examples and from traces of mastic on tools from certain sites (his Fig. 3) that similar microlithic tools must likewise have been hafted, and his point that they would be difficult to manipulate otherwise, might be valid. The shaping of bone and wood may require stable application of a good deal of pressure (Gould 1966; Gould et al 1971) and microlithic tools are frequently so small that they could be held only with the fingertips, providing little stable control over the implement. Some modern peoples still relying on stone tools are hafting certain forms, but these are primarily large (compared to microliths) scraper or adze forms (Gould 1966; Gould et al 1971). Clark goes on to discuss the possible use of rather large crescents from south-central Africa (his p. 148) as adzes, but does not generalize from these to microlithic crescents, similar in many respects except size. An interesting point in this regard is that similar large crescent adzes (eloura) from Australia were mounted parallel to the handle or haft (his p. 148) like an axe blade.

As mentioned above, a small number of tools have been found in eastern Africa with traces of resin still adhering (H. Deacon 1969), but no Later Stone Age "Wilton" site in East Africa has produced any item which could be interpreted as a haft, much less a slotted projectile point, even from sites with high organic preservation (such as Gwisho in Zambia (Fagan and van Noten 1971)). Thus, the evidence for hafting is largely circumstantial and important questions remain: were geometrics hafted singly, in groups, in handles, lumps of resin, parallel to cutting edge or angled? Is the sharp edge the working edge and what are the advantages of composite tools? How can any of these possibilities be proved or disproved?

Function of microliths

Microliths began to appear at a time when peoples in many areas of the world are presumed to have been in the process of a shift to major reliance on cereal grains. Thus, particularly in areas where agriculture is known to have developed very early, microliths are thought to be insets for sickles or reaping knives. Some evidence exists for this conclusion about function, principally, a very characteristic kind of gloss or sheen visible on some of the stone "insets" such as Wendorf (1968) found on geometrics from the late Pleistocene of Nubia.

In much of Africa, however, where agriculture and domestication are presumed to be recent, and in other areas where hunting/gathering persisted until recently, microliths are assumed to be exclusively associated with hunting. A result of the attribution of this function to microliths is the circular reasoning that presence of microliths constitutes evidence for the spread of bow and arrow hunting, even to the extent of implying that the invention of the bow necessitated the invention of microliths.

Thus, many factors have fostered the interpretation of geometric microliths as projectile points or barbs: circumstantial evidence or deduction based on inadequate evidence; certain assumptions about technological backwardness in Africa; misconceptions about the importance of hunting in so-called hunter-gatherer groups (Lee and DeVore 1968); and the considerable weight of the original work and conclusions of L. S. B. Leakey (1931) and others.

Some of the best archeological evidence for function (and incidentally, hafting) of microlithic forms is found far afield of East Africa. Clark (1970) illustrates a slotted handle with a few microliths still in place from the Upper Capsian of Cyrenaicia which is interpreted as a sickle. However, this location is strongly suggestive of the influence of the developing Nile or Middle East Neolithic. In Nubia, there is microlithic material also interpreted as functioning in the context of harvest rather than hunt, even though hunting was a primary activity. Wendorf (1968), in excavating a series of sites representing the heterogeneous culture mosaic of the Nubian Nile

Middle and Final Paleolithic found microlithic assemblages associated with numerous large grinding stones. Faunal remains show however that the subsistence pattern of this Nubian group involved reliance upon hunting of large savanna-type game and fishing, with dental evidence also supporting the basically non-agricultural nature of subsistence (Wendorf 1968, p. 840 and 1035). The importance of harvesting wild grains and seeds was inferred from the presence of the large grinding stones. Microliths were assumed to be related to harvesting rather than hunting.

At one Qadan site (Site 8905 dated to about 12,500 BC) numbers of "lunates" were found which has "lustrous edges" commonly called sickle sheen or corn gloss (Witthoft 1967). In addition, some of these lunates preserved traces of mastic. Wendorf believed the patterns of sheen and mastic indicated angles or possibly parallel mounting of the lunates (his p. 942). He recorded no doubts about the association of microliths with harvesting.

It seems clear that prehistoric "hunter/gatherers" of eastern Africa must have had highly diversified economies, just as "hunter/gatherers" do today. It is this evidence of a wider range of economic activities which has cast most doubt upon the accepted function of microliths. For example, the earliest microlithic occurances in eastern Africa, the Nachikufan, includes, like the Nubian material, a significant microlithic component composed of numerous upper and lower grindstones, as well as ground stone axes and bored stones interpreted as digging stick weights (Clark 1970), all of which attest to the importance of gathered foods. Yet Clark says, "microlithic lunates and semicircles attest to the use of projectiles with both pointed and transverse heads" (his p. 174). This assertion seems based on nothing more than the longstanding equation of geometrics with projectiles (see also Gabel 1965, p. 4) rather than the complex kinds of ecological evidence used by Deacon (1972) to infer hunting strategy. Clark does not mention the nature of faunal evidence to support the hypothesis about hunting strategy.

At another south-central African site, Gwisho B, van Noten explores somewhat the notion of geometrics as projectile points (Fagan and van Noten 1971). The inventory of wood and bone tools from Gwisho B was extensive, but did not include anything construed as the slotted or multicomponent projectile points envisioned by Leakey, Clark and others. Instead, many of the wood and bone artefacts were interpreted by van Noten as analogous to the simple, needle-like, plain or socketed arrows made by the !Kung even today (pp. 103, 111, 115 and Figures 12 and 13). The Gwisho B microlithic component had a very high frequency of geometrics (about 23% of total worked pieces) indicating the importance of these tools, but van Noten was unwilling either to interpret these as arrow tips and barbs or to infer any other function from the available evidence (p. 93). The Gwisho material also includes numerous grindstones, bored stones, hammerstones and digging sticks indicating the complex nature of the economy represented.

Wendorf's Nubian material also provided some evidence against the association of geometrics with projectiles. At the graveyard of Jebel Sahaba, most of the people had clearly been killed with stone tipped projectiles, the pieces of which were still embedded in various parts of the skeletons. Wendorf attributes this graveyard assemblage to the

Qadan (about 13,000 to 5000 BC) for which microlithic lunates are considered diagnostic (p. 990). Yet, only one doubtful lunate was found and it was not in direct association with a skeleton.

Because of the insecure dating for this graveyard, Wendorf notes the possibility that absence of lunates may mean that this site predates their introduction somewhat but considers it more likely that they simply were not used on projectiles. Since the Qadan was a hunting, warring society with a newly expanded harvesting technology, this begs the question of function of geometrics in this context. Interestingly, the Jebel Sahaba shaped tool assemblage closely parallels that at another Qadan site, ANE-1 near Wadi Halfa, which "yielded a very rich Late Plaistocene large fauna" (Wendorf's p. 991), reinforcing the association of tools other than geometrics with hunting of large game there. In discussing further the generally assumed function of geometric microliths, Wendorf notes (p. 991) the large number of unretouched flakes and chips in the Jebel Sahaba arsenal of "irrefutable" weapons. A standard typological classification of this assemblage not only turned out not to contain any of the geometric microliths normally associated with this industry in high frequencies, but broke down into a wide variety of other standard artefact classes, all apparently serving one indisputable function.

Other indirect evidence from North Africa for ancient use of projectiles and possibly arrows are the small tanged and barbed points of the later Aterian (>20,000 years ago, Clark 1970, p. 157). On morphological grounds the functional suitability of these shaped points is more readily acceptable than that of crescents or other geometrics, but evidence for the influence of northwestern and Saharan cultures is lacking in East Africa.

Whether or not the Aterian points were arrow points at that early time, Saharan rock paintings show bow and arrow use there at least by 5000 to 6000 BC (Clark 1970). However, this is considerably later than the Nachikufan in south-central Africa. It does not seem that there is any clear pattern of relationship between the good evidence for bow and arrow hunting, the development of microlithic industries, and geometric microliths in particular. Other kinds of evidence for the presence of arrows, such as the remarkably modern forms at Gwisho, seem much more compelling, but in no way link arrows to microliths.

In South Africa, where the microlithic Wilton industries were first described and defined, there is some indirect but highly suggestive evidence for the relationship of small crescents, other geometrics and backed blade segments with certain hunting practices. Nelson (1971), in assessing Later Stone Age patterning of the "spine of Africa running from the Horn and Ethiopian highlands, though the rift and highland systems of eastern and central Africa, to the mountain systems of South Africa" notes that "microliths and scrapers are distributed in inverse proportions" from north to south with microliths dominating in the north and scrapers in the south. Deacon (1972), in a review of South African Post-Pleistocene industries, describes the covariance of changes in environments, hunting patterns and assemblage content. A similar approach would likely resolve many of the questions raised by the variation revealed for East African material in Nelson's (1971) study. Deacon describes a gradual and probably minimal environmental shift at the close of the Pleistocene resulting in the spread of shrub and bush land at the expense of grassland and the corresponding faunal shift from large gregarious herbivores to smaller, solitary and territorial game as well as ground game. Correspondingly, the scraper-rich Wilton assemblages are associated with these smaller kinds of game throughout the eastern Cape, the south Cape coast and also the inland areas. To the north, however, Wilton-type assemblages (as at Gwisho B) are associated with large, grassland fauna and the percentages of geometrics are very much higher. Although Deacon notes the long presumed relation of microliths to bow and arrow hunting and makes some valid points about the merits of hunting with projectiles in open grassland versus hunting in bushland with trap lines, as we have seen, the link between the microliths and arrows is not strong. The link between microliths and this hunting strategy may be valid, but it remains to demonstrate exactly what the nature of this link is.

I do not mean to suggest by all of this that microliths cannot be related to hunting in some way or that they must be related to vegetal resource exploitation. What does seem clear is that Post-Pleistocene economies were, as expected by analogy with modern peoples, highly diversified; that the evidence that microliths are exclusively associated with hunting is far from conclusive; and that the potential for elucidating the technological role of microliths is increasing. If technology is indeed our major key to the total cultural system, then it is imperative that the utilization of microliths be understood.

Morphology and dimensions

Although quite a large number of "Later Stone Age" sites have been excavated in the last forty years, for most of these only partial artefact inventories remain. Classifications have tended to follow early examples, being more or less elaborate and always excluding unretouched pieces. These traditional classifications, as well as more recent ones, have emphasized the morphological heterogeneity of forms all the while assuming functional homogeneity.

Early workers (Leakey, O'Brien, and others) seemed to have a secure perception of what constituted a geometric microlith. Geometrics were assumed to form a discrete functional class even though a wide range of shape variation was described. The firm perception of these shape sub-classes seems to have resulted in a good many odd or crudely made backed items being simply overlooked in favor of the good diagnostic types.

Recent work continues to focus on description and classification and has resulted in more subdivision of microlithic industries but less uniformity of perspective among workers (see note, p. 15). In general, much attention has been paid to typological subdivision of geometrics where the frequency in site assemblages is high, namely, East Africa. In South Africa, where assemblages are scraper-rich, geometrics are descriptively subsumed into one category, "backed tools" (J. Deacon 1971). Nelson's approach (Posnansky and Nelson 1968; Nelson and Posnansky 1970) is most formally typological in perspective, while that of van Noten (Fagan and van Noten 1971) seems to evolve from a perspective on function and utilization. Whereas Nelson's primary classes are tools, cores and debris, van Noten's primary classes are worked pieces, utilized pieces and waste (waste includes cores). Nelson's category of microliths includes all small shaped items with one or more blunted edges and subsumes crescents, triangles, "truncated pieces" and "nonregular" backed items. van Noten relegates truncated and other nonregular blunted pieces to another category, presumably with different functional implications.

In general, geometrics are subdivided according to a variety of nonexclusive criteria. Major points of disagreement seem to center upon: 1) item height, some using this attribute to delineate subcategories, others regarding it simply as a variable within a category having a continuous range; and 2) symmetry, some regarding symmetrical and asymmetrical items as essentially the same tool while others divide them into completely different subcategories.[1]

An assumption frequently underlying recognition of distinctive artefact forms is that task requirements generate specific needs expressed in aspects of morphology. Thus, microlith morphology is widely thought to reflect requirements of compositie projectile head fabrication. Conversely, if tools display repetitive combinations of attributes, these are usually thought to reflect specific task requirements (Wilmsen 1968). For microliths, the primary criterion for the types recognized is plan-view shape, but nowhere are the boundaries of variation for other attributes defined (e.g. dimensions, cross-section; edge-angles).

It is not even possible to compare the dimensional variation of types or classes. The primary reason is that few researchers (except Nelson) report the ranges, averages and sample sizes for dimensions. Another equally unfortunate circumstance rendering comparison impossible is that, beyond simple crescent shapes, definition of types are far from

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[1]The reader may compare Posnansky and Nelson (1968); Phillipson (1969); Nelson and Posnansky (1970); Fagan and van Noten (1971); and Wendorf (1968).

similar and even when the list of types used by two different workers seem to be similar, a look at the illustrations and stated definitions usually reveals that the types subsume the artefacts in entirely different ways.

Many recent reports have contained comments on the overlapping nature of shape variation. Nelson says that "curved backed blades and flakes" (asymmetrical crescents) "intergrade with crescents" (p. 129, 1970). Phillipson (1969) regards all the geometrics from Nakapapula Rockshelter as "crescents" but notes that they can be subdivided into four groups based on shapes which "merge into one another" (his p. 179). van Noten (1971) in the analysis of the enormous collection from Gwisho notes that classes of items usually share only one characteristic. They are "earred," triangular, circular, but have no other characteristics in common (his p. 89). He interprets this to mean that "these artefacts form a continuous series passing gradually from class to class representing a stereotyped "cultural tool"" (p. 89). These comments about "merging" and "continuous" series however, are based entirely upon a visual assessment of intergrading shapes. No actual attempt has been made to rank the types and intermediates into any sort of linear or evolutionary series and this is not likely to occur because the types form no series but grade into each other equally (see Figure 13, page below).

There seem to be four alternatives for evaluation of conventional types: 1) geometric types are in fact discrete and implications of form for function are valid; 2) types are intentional (perhaps stylistic) variations on a single theme without specialized functions; 3) types are not discrete but are accidental variations and all actually represent the same tool; or 4) types are accidental, but geometrics can be divided into different tool categories based on combinations of attributes unrelated to shape. Another way of saying this is, does the variation reflect anything of cultural significance? Did the tool makers recognize the classes of shape and if so, what was the functional or stylistic basis for the shape distinction?

Some descriptive kinds of analysis must be performed before the above hypotheses can be refined and tested. As mentioned above, tests for homogeneity at the site, area, region and interregional level would confirm or refute what are now merely impressions about the validity of geometric types. Other kinds of analyses for discovery of types would complement these tests. However, as Nance (1970, p. 67) points out, "stylistic variation is more relevant when we can understand what the variation means relative to a particular functional category of artefacts." So, even though much could be done to resolve the question of validity of types by more critical reanalysis of type frequencies and morphological variation, it is by no means certain that this would also resolve the issue of function for this East African material.

Traces of manufacture and utilization

Examining the evidence for function of geometrics has laid waste to some traditional conclusions without firmly indicating others. One type of evidence directly linked to tool usage is the damage done to the tool in the performance of its function. The evidence holds enormous potential for determining utilization patterns and relating them to morphological patterns. The damage done during manufacture, use and abuse may reveal by its character the direction and force of stress occurring on the edges and faces of the tool and thus imply certain modes of use which in turn may be linked to certain activities. Only one use-wear analysis has been carried out on Later Stone Age materials, that of the Phillipsons in their report on rock shelter material in Zambia (1971). Their research and conclusions will be considered at length within the discussions of results of this study.

CHAPTER II

THE RANGI SITE

This analysis of microlith function was conducted on a microlithic assemblage from Uganda. The Rangi site is located on the southern lower slope of Kadam Mountain approximately a mile due west of a very small community called Katabak consisting of a small school, a bore hole and a few shops. The site is situated on the slope of a spur of the mountain just above a natural *cul-de-sac* in front of a shallow cave or shelter. The site provides a clear view over the level area of the *cul-de-sac* for about 100 yards and Mount Elgon is visible over the tops of the trees on the plain. The site takes its name from the local Swahili designation for the area referring to the colorful rocks.

The site was excavated in 1970 by Dr. L. H. Robbins of Michigan State University along with Ms. M. E. Robbins, S. McFarlin, M. Kalmanovitch, S . Rueben, H. Rueben, D. Pokolem, J. Akmoit, and various other Pokot people. The field work was made possible by permission of the Uganda Government through the Inspector of Monuments, Mr. Hamo Sassoon. National Science Foundation Grant GS-2642 and the African Studies Center, Michigan State University provided financial support.

Kadam Mountain (10,067') rises as a single peak from the plateau of southern Karimoja, which is itself 3700-4500 feet high. Within sight (about 17 kilometers or 11 miles) to the southwest is the volcano of Mount Elgon on the border of Uganda and Kenya. The land between Kadam and Mount Moroto to the north in the Great Rift forms a rocky watershed[1] dividing the Kanyangareng-Suam-Turkwell river systems which run east to Kenya from the other rivers of Karimoja which flow generally west, degenerating into seasonal swamps. Few of these rivers of southern Karimoja are permanent. Channels fill for a few hours after rains, and water collects in rocky pools or reservoirs for variable periods. In the middle courses on the plateau, rains often cause wild, temporary flooding. In the highland areas, water is caught in rocky cavities and may last for several weeks after a rain.

The vegetation of southern Karimoja varies from dry thorn scrub to broadleafed deciduous woodland with a ground cover of perennial grasses. Overgrazing in many areas has seriously affected and in some cases destroyed the natural ground cover. Although the region around the site sees a certain amount of human use, including burning for cultivation and grazing, the tall grass and tree ground cover is fairly extensive with more dense vegetation along the dry watercourses. Severely eroded areas do exist however. Going up the mountain, the grass and trees continue with numerous rock outcrops changing to dense forest at higher elevations.

Rainfall in Karimoja can only be characterized as erratic. Although the amount generally averages about 25 inches in much of the plains and about 35 inches annually at higher elevations and in the

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[1]Environmental information is summarized from Dyson-Hudson's (1966) very extensive account of the area, field notes from the 1970 excavation and personal communication with L. H. Robbins.

mountains, the range at any given location over a period of years may vary from 18 to almost 60 inches. A rainy season/dry season regime is generally recognized, but historically the incidence of rain varies from all in one month to evenly distributed throughout the year (see Dyson-Hudson's thorough analysis (1966) of Karimojong economy as a response to environmental factors).

The region around Kadam is presently inhabited by a number of ethnically distinct groups. A line drawn through Kadam and Moroto Mountains approximately divides the Karimojong in the central riverine area from the Pokot who occupy the eastern part of the plateau and highlands. The Karimojong pastoralists are the largest group in southern Karimoja. The Pokot are fairly recent arrivals from Kenya having achieved their present position and territory by a gradual absorption of grazing land through temporary government concessions. They are considered "foreigners" or "enemies" by the Karimojong along with the Bebei and Bagisu (south of Kadam), the Teso (southwest and west of Kadam), and the Tepes or Tepeth who live higher up on Kadam itself. At the time of the excavation, the region of the site was occupied primarily by Pokot people with the exception of the Tepeth much higher up on the mountain. Little is known of the Tepeth, but it is thought that their presence there is quite longstanding.

As mentioned above the site[1] is located on the slope in front of a natural shallow cave or shelter which was probably formed by water erosion and collapse. The shelter is approximately 22 meters wide and 10 meters deep. The shelter itself is large devoid of all but recent

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[1]The following information was derived primarily from discussions with L. H. Robbins and follow his estimates and impressions.

cultural material. Modern peoples use the cave for storage and temporary stopovers. The cave affords a good natural lookout and is a comfortable spot in which to catch the afternoon sun.

Two test pits were sunk below the shelter on the slope and revealed an extremely dense assemblage of lithic remains, faunal remains and pottery. The deposit may represent refuse thrown out of the shelter or it is possible that the slope in front of the cave was the actual locus of activities. Eventually, eight two-meter squares were excavated to depths averaging 200-220 centimeters below datum. The depth of the deposit varied due to the slope of the surface. Material from the first square was passed through a 1 centimeter gauge screen; thereafter, 0.5 centimeter gauge screen was used. All material believed to be of human or cultural origin was preserved including chipped and ground, pecked or battered stone, pottery, bone, charcoal, iron fragments and ostrich eggshell.

No stratigraphy that could be associated with human action could be discerned in the test excavations, but the site resolved itself into three fairly well defined natural layers. The top layer was a surface humus ranging from 5 to 20 centimeters thick. It was clear that the surface vegetation had been burned over once if not many times in the recent past. This layer did not contain the large quantities of prehistoric material that the two lower layers did.

The next natural layer was a grey-brown soil ranging from 25 to 75 centimeters in thickness and it was estimated that at least 90% of the cultural material was found in this layer. The artefactual material was extremely abundant and devoid of recent material. There were no readily discernable features in this layer beyond occasional rock concentrations which may or may not have been hearths. Below this rich artefact zone was a rocky layer consisting largely of decomposed bedrock and rubble. Artefacts were still present but faunal material became scarcer and more large chipped stone items appeared. These three layers were fairly continuous over the area in front of the shelter, but thicknesses varied and transitions were not always easy to pick up.

Iron artefacts consisted of pointed objects, possibly knives or points, and rings about 2 inches in diameter which may have been bangles. Although not abundant, iron is present in all three layers. It is not yet clear whether these objects were made at this stie but this is considered unlikely. Conspicuously absent were any iron objects which might have been agricultural in nature, such as hoe tips, which do occur at other sites on the plain near Napak Mountain to the northwest.

Pottery as well was distributed throughout the layers, although once again, it was not very abundant in the bottommost layer. It is possible that unknown disturbances such as rodent burrowing would account for the presence of iron and ceramics in the lowest layer. An analysis of the ceramics from the Rangi site is presently being carried out by Shela McFarlan (California State University at Fresno) and may answer many questions of stratigraphy and affinities of the site with other areas. A wide variety of ceramic types are present including a rouletted type which may show a relationship with some open sites in Karimoja where it is associated with large milling stones, iron hoe tips and pipes and broken clay pipe fragments, but no chipped stone. The association of this pottery with rouletted decoration with the so-called Sirikwa holes of western Kenya is also noted by Sutton (1966).

These features have been interpreted as fortified cattle enclosures associated with houses and a presumably settled, partially agricultural people. These occurances date at least to the sixteenth century and possibly earlier. At least one site (Kabyoyon Farm) is located in the northeastern foothills of Mount Elgon not far from Rangi.

Macrolithic artefacts seem to be restricted to a limited size range of grinding stones, hammer stones or pounders, dimpled stones, some cobbles which may be partially bored, and a very few, broken bored stones which resemble those usually assumed to be digging stick weights. The largest basal grind stone is only about 6 inches square. Large flaked stone tools are not common and seem to be more prevalent in the deepest layer of the site. Nothing that could be interpreted as either ground stone axes or adzes was found. Many of these macrolithic items seem to have been multipurpose, showing combinations of grinding, battering or pecking. This possibly accounts for the fragmentary nature of much of this material.

An analysis of the faunal assemblage is presently being conducted and should yield much useful information regarding seasonality and site economy. At present, it appears that the fauna represent an orientation to rather large, gregarious herbivores such as zebra, greater kudu, and large antelope. Although rodents, birds, baboons and various reptiles are represented, they are not present in significant numbers, nor has any evidence so far been discovered of any kind of domestic animals. All of the bone is highly fragmented, probably indicating more than a passing interest in bone by-products such as marrow and grease. Many bone fragments show cut marks and other evidence of butchering.

C^{14} dates for the Rangi site put the time period involved on the order of 500 years ago (bone sample N-863: 510±105 years ago). Because of the extensive burning in the area of the site and some preliminary conclusions about the pottery component, it is felt that the site may actually be somewhat older, possibly on the order of 1000 years ago. Even this earlier date seems late for a site showing no apparent reliance on domestic animals. Both Sutton (1966) and Nelson (1971) describe widespread introduction of domestic stock earlier than 2000 years ago, but Nelson in particular notes that local adoption varied and in some cases did not occur.

The Rangi assemblage seems to represent the possibly temporary but repeated occupation of a shallow cave low on the slope of Kadam Mountain. The primary activity taking place during the occupation of the shelter is believed by the excavators to have been hunting and perhaps processing of the carcasses. The character of the Rangi chipped stone microlithic component corresponds generally to other East African Post-Pleistocene assemblages. Preliminary appraisal of the material seems to indicate a high percentage of waste with shaped tools dominated by various backed geometrics and blades and small scrapers. It seems to fit Sutton's (1966) and Gabel's (1969) concepts of a generalized, microlithic "Wilton" with few long blades or burins. It is perhaps more accurately characterized in Nelson's terms (1971) as a "standard" but late or terminal Later Stone Age occurance with pottery.

Although the site was excavated by arbitrary levels and there was some slight evidence of natural stratigraphy, in the end artefact location was ignored as a factor or variable for the purposes of this study. The implications of the natural stratigraphy were too vague to be of any use and no features or activity areas were discerned with confidence.

In addition, there was the distinct possibility that the stratigraphy was either inverted or mixed as a result of periodic cave cleaning.

CHAPTER III

THE ARTEFACT SAMPLE

Formation of a minimum working definition

Since existing classifications and definitions employ far from uniform criteria for type classes and, in fact, even perspective on classification varies, the first problem encountered turned out to be deciding what items to include and not include as geometric microliths. Resolution of the various classification conflicts already discussed was not considered essential for this study, but some operational definition was required in order to select relevant items. Since the general research question involved the long-presumed function of geometrics, namely that they were hafted insets for projectiles, and even the most elaborate classification scheme seemed to rest upon this assumption, a very simple definition was developed based upon those attributes traditionally cited as indicative of function and hafting. A sharp, original flake edge opposed to a blunted edge was considered to provide the most consistently applicable working definition.

Using Nelson's scheme (Nelson and Posnansky 1970), many items included here would fall into other subcategories of microliths than geometrics. For example, items in his classification called "curved back" flakes and blades are called asymmetrical crescents by others[1] and were included because they fit the minimum definition. The rule

[1]Wendorf (1968); J. Deacon (1971); Fagan and van Noten (1971); and Phillipson (1969).

of opposition of sharp and blunted edges in turn excludes what he calls "perpendicular truncations" and also double-backed items, both of which he classes as geometrics.

Therefore, items selected for this study all possess a blunted vertical or near vertical back (of a variety of shapes) in opposition to a sharp, original lateral flake edge. In addition, a further restriction was imposed that at least part of the blunt edge be formed by intentional removal of small, contiguous flakes directed from either one or both faces of the implement. This restriction may well have resulted in exclusion of items which functioned similarly to those with intentional retouch, but was deemed necessary considering the limits and objectives of this study.

There was a rather large number of these items in the collection which conformed to the first criterion (a blunt edge opposed to a sharp edge), but not the second (that of intentional blunting). These items were cortex-backed or fortuitously backed by snaps or breaks with no readily noticeable features to indicate intentional shaping. If the complete assemblage is ever analyzed and the relative significance of these pseudo-geometrics can be assessed, it may then be possible to judge the appropriateness of including them in this kind of analysis.

"Backed blades"

An initial sort of the material was made to eliminate items without intentional blunting and to distinguish conventional categories of crescents, other geometrics and backed blades. It was during this sorting out of items suitable for this analysis that the first hint of confusion arose about the morphological relationship of so-called "backed blades to other geometrics. Initially, the category seemed less tenuous than crescents, triangles or trapezoids which all seem to grade into each other. Then, more careful consideration of published typologies revealed that definitions for "backed blades" varied a great deal. If the definition were broad, then the category seemed to include all items not readily subsumed under other categories. Stricter definitions tended to create additional categories for the residual "miscellaneous backed pieces." Items usually classed as backed blades frequently differ from true geometrics in that they may lack points on one or both ends. Although this morphological difference would seem to bear on the conventional interpretation of backed microliths as arrow barbs, standard classifications lump them together functionally, and so I included them. Also, they do fulfill the minimum definition.

Advantages of the working definition

Restricting the sample of items on the basis of what Wilmsen (1968) calls "culturally imposed" phenomena conforming to the above criteria probably serves several purposes: 1) tools which conform so closely in morphological attributes possibly did serve the same variety of uses; 2) restricting the sample to intentionally shaped pieces increases the likelihood that only tools were included and will display use-wear rather than accidental wear; 3) the likelihood of including patterns of use-wear associated with other functions is possibly reduced; and 4) the restriction to items intentionally modified was also necessary in order to bear directly on the common assumptions about these tools

As Wilmsen (1968) points out, modification of a piece of raw material (in this case, flakes of stone) is "carried out primarily to increase the suitability of a flake for certain functional ends, and it may be thought of as indicative of those ends" (his p. 156). It may follow that the more extensively an item is modified (in terms of the percentage of its surface or edge consistently subject to retouch in order to be considered "finished" or the narrowness of the range of attribute variation), the more exacting the functional requirements may be. Nearly all microliths possess sharp edges and this is everywhere assumed to be the "business" end of the tool. Yet, equally important for the proper and efficient functioning of these tools was a carefully modified blunt edge repetitively considtent in its characteristics. The energy necessary for this modification may be a measure of its significance in the eventual use of the tool.

The reader may perhaps suspect at this point that I am trying to use the traditional justifications for artefact typologies in order to justify using no typology at all, and this is perhaps the case. My objective here was to reduce the morphological criteria to the lowest common denominator without eliminating very many items normally subsumed under this functional interpretation. The traditional functional model for these items emphasizes just those minimum morphological components which I have used to isolate items for examination. Therefore, the items which have been included under my minimum definition ought to reveal the same traces of utilization, and in fact, if the functional interpretation is correct, they ought to reveal wear related to being hafted and used as projectiles or at least show no wear attributable to other functions, especially if they were hafted as barbs as is presumed.

Range of morphological variation -- preliminary remarks

The minimum definition subsumed all the variation in the plan-view shape. Nevertheless, a good deal of variation did exist and an effort was made to describe and determine the significance of this variation. In order to describe the range of variation in shape without having to plug each artefact into a superimposed category based on the sum of its shape characteristics (thus running the risk of emphasizing some characteristics and excluding others), the generalized form of the microliths was broken down into three components: 1) the back, or blunted edge; 2) the sharp edge; and 3) the cross-section. In order to begin, the variation in shape of these components was then subdivided according to published descriptions of other microlithic assemblages. This was relatively simple for the blunted back. All typologies are based upon the variation of this feature. With several published reports in hand, it was relatively easy to develop an extensive list of possible variation.

There was a good deal less attention paid in the published material to variation in the sharp edge. Most authors (van Noten (Fagan and van Noten 1971) is the exception), if they discussed this feature at all, noted only that the sharp edge might vary from concave to convex. This variation was never used as a criterion for types. The situation was even more extreme for variation in cross-section, as it has not been considered a significant feature or attribute.

As work progressed, empirical observations were used to refine and revise the shape categories to reflect the nature of this particular collection. The lists of variation are shown in Figure 1 below.

Sharp Edge	Blunted Back
Straight	Symmetrical crescent
Convex	Earred
Concave	Circular
Sinuous	Triangular
Notched	Trapezoidal
Broken (all or part of edge snapped off parallel to edge)	Straight
	Curved
Cross-Section	Asymmetrical
Pie-shaped	Other
Prismatic	
Triangular	
Subtriangular	

Figure 1: Subdivision of Morphological Variation

It developed that some of the descriptive subdivisions were not mutually exclusive. For example, a sinuous or irregular sharp edge was usually also concave, straight or convex as shown in Figure 2 below. The same held true for notched edges. Broken edges were usually rendered straight by the break.

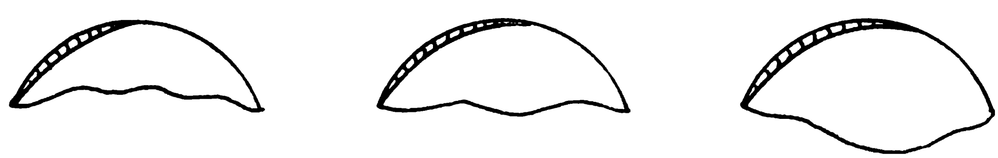
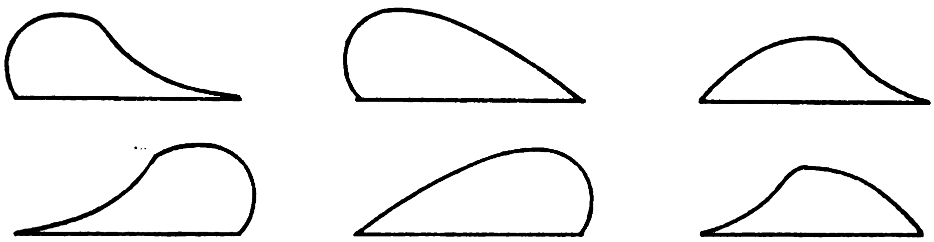


Figure 2: Combined Subdivisions of Sharp Edge Variation

For the shape of the back, asymmetrical shapes were always described in terms of the dissimilar shape components they included, recorded in the proper order from left to right (see discussion of standardized orientation, p. 82). The proscription of a standardized orientation resulted in pairs of categories which were mirror images. Each of the examples in Figure 3 below is of this type. This arbitrary distinction was preserved during the data collection, but was not considered as a variable in the analysis of morphology.

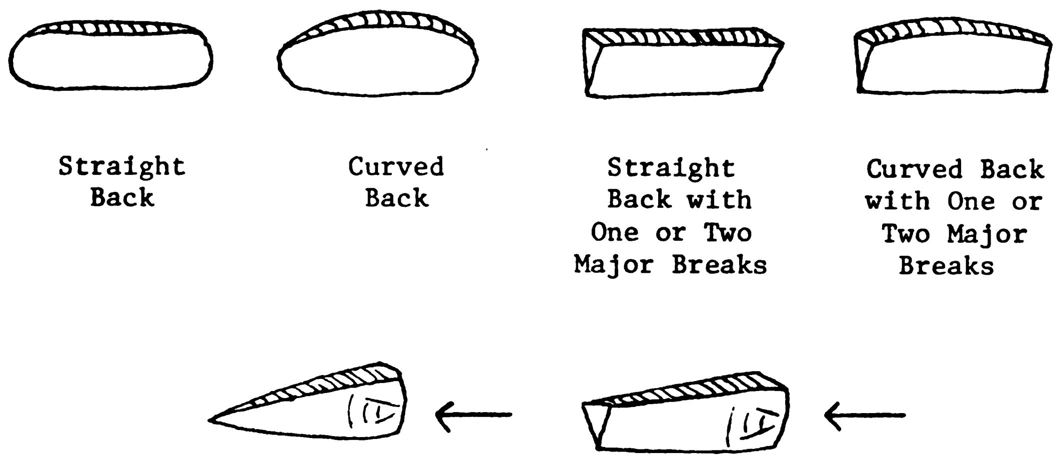


Asym $\left\{\begin{matrix}\text{earred + circ}\\ \text{circ + earred}\end{matrix}\right\}$ Asym $\left\{\begin{matrix}\text{circ + cres}\\ \text{cres + circ}\end{matrix}\right\}$ Asym $\left\{\begin{matrix}\text{cres + earred}\\ \text{earred + cres}\end{matrix}\right\}$

Figure 3: Examples of Mirror-Image Categories

The refinement of descriptive categories for variation in back shape raised again the problem of non-geometric backed items or "backed blades." On these items, the blunting might be straight or gently curved and, whereas on standard geometric types, the back was usually longer than the sharp edge, on these items, the reverse was often true. If the item had one or two major breaks perpendicular to the long axis, the blunted edge and sharp edge would be nearly equal, but not intersect. Figure 4 shows some typical combinations of these morphological components, all conventionally classed as "backed blades."

Another form not clearly a geometric retained the striking platform on one end of the item, but did not clearly incorporate it into the blunting. As shown in Figure 4, these might or might not possess a point as do geometrics, yet not be true geometrics. Following most classifications,[1] these items would have been lumped into one category -- backed blades. The immediate problem concerned the pointed form and whether to follow the Phillipsons (1970) and call these backed blades or Wendorf (1968) and call them J-shaped pieces. I decided to class them with the blades whenever the striking platform was not clearly an extension of the blunting.



Non-geometric forms preserving the striking platform

Figure 4: Typical Non-Geometric Forms

The categories for cross-section simply represent those observed. A prismatic cross-section merely represents the presence of a scar from a previously detached flake on the upper face (this is also one of the criteria for defining the upper face, see p. 82).

The shape classifications I established obviously crosscut some traditional formal type-categories, but this system represents inclusion of a substantial amount of additional and possibly significant variation.

[1]Phillipson and Phillipson (1970) use this feature as a primary criterion for distinguishing "backed blades," but this results in creation of another category for items not showing intersection of back and sharp edge without preserving striking platform.

The additional variation included was derived primarily from original flake characteristics. Previous classifications have concentrated almost exclusively on variation produced by human activity, but all characteristics may represent choice on the part of the human agent and this is the major justification for describing all variation.

Sample Size

The chipped stone component of the Rangi assemblage numbered in the tens of thousands of pieces. This enormous collection finally yielded 234 items which fit the minimum morphological definition adopted for this study. Most of these items were included in the analysis of morphology and dimensions (see Chapter IV), but ultimately, only forty tools were examined microscopically for traces of utilization. At first, the size of the sample of tools examined was regarded as uncomfortably small. Indeed, it was too small for powerful statistical statements or good correlations with the results of the morphological analysis. Although clear patterns could be discerned, these were not free of ambiguity. Nevertheless, a larger sample would have been extremely awkward and discouraging to manipulate as this one was in the process of discovering patterns and trends. In the absense of preexisting data or information which could be used to predict pattern or formulate specific questions, many, many operations had to be performed for which value could not be determined in advance. The lack of preexisting data was particularly acute in this case. Without being able to make specific predictions about the function of microliths, it was not even possible to know for sure what sorts of data would turn out to be most useful. Consequently, a great deal of data was recorded, some of which turned out to be useful and some not. Inevitably, many of the questions stimulated in the course of the analysis required data which was either insufficient in quantity or not taken at all. The analysis of the data also necessarily involved a great deal of completely unrewarded effort because it was exploratory and almost entirely self-contained and self-stimulating. Yet, with the kinds of specific questions generated by the patterns discovered here, it is quite clear that a new analysis of similar tools could proceed efficiently and with maximum recourse to quantitative methods and techniques.

CHAPTER IV

ANALYSIS OF MORPHOLOGY AND DIMENSIONS

Part 1: Morphology

Frequency distribution for all morphological variation defined for this study

A total of 219 items were included in the snape analysis. Of these, six had had their sharp edges snapped off parallel to the edge and so were not included in the comparisons of variation in that edge. Fifteen items among those available were excluded altogether because major breaks rendered determination of form uncertain. They were however included in the analysis of breakage (see Chapter V). Broken items normally classed as "backed blades" were not excluded.

The raw breakdown of variation in the shape components is shown in Table 1 below:

TABLE 1

FREQUENCY DISTRIBUTION FOR ALL SHAPE VARIATION

Sharp Edge	f	%	f	%
Straight			65	29.7
Convex			30	13.7
Concave			19	8.7
Sinuous			77	35.2
Straight	45	58.4		(20.6)
Convex	25	32.5		(11.4)
Concave	7	9.1		(3.2)
Notched			22	10.0
Straight	15	68.2		(6.8)
Convex	5	22.7		(2.3)
Concave	2	9.1		(0.9)
Broken			6	2.7
			219	100.0

TABLE 1--Continued

Blunted Back	f	f	%
Symmetrical crescents		59	26.9
Symmetrical earred		0	0.0
Circular		7	3.2
Symmetrical triangles	9	13	6.0
Asymmetrical triangles	4		
Symmetrical trapezoids	12	19	8.7
Asymmetrical trapezoids	7		
Straight backed blades		17	7.8
Curved backed blades		47	21.5
Asym (cres + cres)		24	11.0
Asym (cres + earred)	5	8	3.6
Asym (earred + cres)	3		
Asym (cres + circ)	13	22	10.0
Asym (circ + cres)	9		
Asym (earred + circ)	1	2	1.0
Asym (circ + earred)	1		
Other		1	0.5
		219	100.0

Cross Section	f	%
Pie shaped	79	36.1
Prismatic	102	46.6
Triangular	30	13.7
Sub-triangular	6	2.7
Other	2	0.9
	219	100.0

Frequency distribution for some standard shape categories

Table 2 below shows a conventional classification of the material included in this study. It is based only on the shape of the back as are other typical classifications. The category "crescents" includes: 1) symmetrical crescents; 2) circular crescents; 3) asymmetrical crescents (cres + cres); 4) asymmetrical (cres + earred); and 5) asymmetrical (earred + cres). Figure 5 below illustrates the items included in this conventional category.

Figure 5: Items Subsumed by Conventional Category "Crescents"

The category of triangles includes all clearly three-sided items (one sharp edge and two blunted edges) both symmetrical and asymmetrical. Likewise, trapezoids include items with one sharp edge and three straight blunted edges, both symmetrical and asymmetrical. J-shaped pieces include: 1) asymmetrical (cres + circ); 2) asymmetrical (circ + cres); 3) asymmetrical (earred + circ); and 4) asymmetrical (circ + earred). Figure 6 below illustrates the items included in this conventional category.

Figure 6: Items Classed Conventionally as "J-Shaped"

The category "blades" includes items not clearly subsumed by other categories (see discussion on p. 33 and 34). There was one other backed item in the sample which was so irregular that it simply did not fit any category.

TABLE 2

FREQUENCY DISTRIBUTION FOR CONVENTIONAL SHAPE CATEGORIES

	f	%
Crescents	98	44.7
Triangles	13	5.9
Trapezoids	19	8.7
J-Shaped	24	11.0
Backed Blades	64	29.2
Other	1	0.5
	219	100.0

Variation of some individual aspects of morphology defined for this study

The tendencies and modalities of variation were examined for several shape components. Then, many of these components were tested for strength of association with each other.

Number of points. -- In addition to the sharp edge, the points on these items are traditionally assumed to be of functional significance either as pointed barbs for composite arrow heads or at least as drills or piercing tools. Table 3 and Table 4 show the variation in number of points for this sample from two different perspectives.

TABLE 3

GROSS VARIATION IN NUMBER OF POINTS PER ITEM

	f	%
Two points	125	57.1
One point	58	26.5
No points	36	16.4
	219	100.0

The strong preference for items with two carefully fabricated points is suggestive. If these items were in fact barbs for arrows and were hafted in the manner assumed, it would be more logical for there to be a strong preference for single pointed items. The possibility of their functioning as drills or piercers would carry an even stronger logical expectation for single pointed items. This argument from morphology to function in no way constitutes proof or disproof of the functional interpretations made previously or here. It is merely the same kind of argument used to support traditional interpretations and one which is just as compelling (or uncompelling).

The frequencies displayed in Table 3 did contain broken items conventionally classed as whole backed blades. Since the definition for backed blades was based on some untested assumptions about snaps being intentional, those backed blades having snaps were eliminated from the sample and the proportions changed as shown in Table 4.

TABLE 4

VARIATION IN NUMBER OF POINTS PER ITEM
(without snapped blades)

	f	%
Two points	125	62.5
One point	56	28.0
No points	19	9.5
	200	100.0

Eliminating items which might be broken and thus not displaying their true character increased the preference for two-pointed items overall, but also increased the apparent preference for one-pointed items at the expense of items with no points.

Symmetry. -- A morphological variable frequently mentioned in reports but seldom discussed in terms of its relevance for function is symmetry. If the entire sample is considered, the percentages of symmetrical and asymmetrical items are nearly equal (see Table 5).

TABLE 5

PREFERENCE FOR SYMMETRY FOR ENTIRE SAMPLE

	f	%
Symmetrical	106	48.4
Asymmetrical	113	51.6
	219	100.0

Among two-pointed items the proporations change, indicating a preference for two-pointed items to be symmetrical. Every category showed a preference for symmetry similar to that shown by the group

TABLE 6

PREFERENCE FOR SYMMETRY AMONG TWO-POINTED ITEMS

	Symmetrical		Asymmetrical		
	f	%	f	%	Total
Crescents	59	71.1	24	28.9	83
Triangles	9	69.2	4	30.8	13
Trapezoids	12	63.2	7	36.8	19
Blades	2	--	0	--	2
Asym (cres + earred)	0	--	8	--	8
Total	82	68.6	43	34.4	125

Since the limits of symmetry and asymmetry were very strictly interpreted, it may well be that symmetry was a more closely approximated ideal than the above percentages reflect. In other words, the maker's goal of symmetry may have had a certain tolerance of variation which I did not allow. This may be especially true of Asym (cres + cres) pieces, but also of Asym (cres + earred) items which seem to involve a very minor variation from symmetrical crescents (see Figure 7). It is

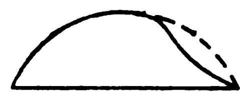


Figure 7: Variation from Symmetry of Asym (cres + earred) Pieces

possible that the goal of a symmetrical item and a two-pointed item were one and the same goal. This may reflect a real dichotomy between symmetrical two-pointed items and asymmetrical one- or no-pointed items.

Characteristics of the original lateral flake edge. -- As already noted (p. 32), two possible perspectives could be taken on variation in the character of the unretouched, original flake edge. The edges could be classified according to whether they were concave, straight, or convex, and also according to whether they were smooth or sinuous. Of the unbroken sample (N = 213), 53.5% had smooth or regular sharp edges, 36.2% had sinuous or denticulate-like edges, and 10.3% had notched edges. If the notched pieces (which occurred predominantly on smooth edges and were mainly the result of snaps along fracture planes) are added in, the percentages become 63.8% vs. 36.2%.

Among both these groups, smooth and sinuous (smooth including the notched pieces), the preference was decidedly for straight edges rather than concave or convex (see Tables 7 and 8).

TABLE 7

PREFERENCE FOR SMOOTH EDGES

	Straight		Convex		Concave		Total	
	f	%	f	%	f	%	f	%
Smooth	80	64.0	35	58.0	21	75.0	136	63.8
Sinuous	45	36.0	25	42.0	7	25.0	77	36.2
Total	125	100.0	60	100.0	29	100.0	213	100.0

TABLE 8

PREFERENCE FOR STRAIGHT EDGES

	Smooth		Sinuous		Total	
	f	%	f	%	f	%
Straight	80	58.8	45	58.4	125	58.7
Convex	35	25.7	25	32.5	60	28.2
Concave	21	15.5	7	9.1	28	13.1
Total	135	100.0	77	100.0	2.3	100.0

The preference for straight edges was the same among both smooth and sinuous edges. X^2 analysis showed a probability of 0.3 - 0.2 for accidental association of these variables. This seems high, but, once again, it is possible here that the tolerance in variation which I allowed for classification was much less than that of the manufacturer. If this is true, the frequencies for straight edges and also smooth edges would be higher and the correlation stronger.

Sharp edge characteristics vs. number of points. -- When this variation in sharp edge was compared to variation in number of points, there was evidence of only one marked preference. That was for one-pointed items to have smooth edges (Table 9). On other items there was no apparent strong preference. Likewise X^2 analysis showed a fairly high probability of 0.3 - 0.2 for accidental association of these variables. When straight, convex and concave smooth edges were compared to number of points (Table 10), all three categories revealed preferences for straight edges although the preference was much less marked for two-pointed items.

TABLE 9

EDGE REGULARITY VS. NUMBER OF POINTS

	Two points		One point		No points		Total	
	f	%	f	%	f	%	f	%
Smooth	62	57.9	35	68.6	18	52.9	115	59.9
Sinuous	45	42.1	16	31.4	16	47.1	77	40.1
Total	107	100.0	51	100.0	34	100.0	192	100.0

TABLE 10

SMOOTH EDGE VARIATION VS. NUMBER OF POINTS

	Two points		One point		No points		Total	
	f	%	f	%	f	%	f	%
Straight	32	51.6	21	60.0	12	66.7	65	56.5
Convex	21	33.9	6	17.1	3	16.7	30	26.1
Concave	9	14.5	8	22.9	3	16.7	20	17.4
Total	62	100.0	35	100.0	18	100.0	115	100.0

Among sinuous edges, the preferences change (see Table 11). Now on two-pointed items there is a stronger preference for edges not to be convex or concave. For one-pointed items, there is now a slight preference for convex edges. For items without points the preference continues for straight edges. The general preference of the two samples for

for straight edges however is similar.

TABLE 11

SINUOUS EDGE VARIATION VS. NUMBER OF POINTS

	Two points		One point		No points		Total	
	f	%	f	%	f	%	f	%
Straight	28	62.2	7	43.8	10	62.5	45	58.4
Convex	12	26.7	8	50.0	5	31.3	25	32.5
Concave	5	11.1	1	6.2	1	6.2	7	9.1
Total	45	100.0	16	100.0	16	100.0	77	100.0

This lack of marked or consistent tendencies or correlations for variation in sharp edge with these other aspects of morphology may reflect several things. Functional requirements may in fact be satisfied by the few tendencies noted. That is, the functional need for pointed items may not carry with it any requirement for the character of the sharp edge. In this case, the modalities of variation may reflect simply the modalities of variation for a general population of flakes.

The preference for symmetry among two-pointed items may or may not reflect any real interest in symmetry. Symmetry may only be an incidental result of fashioning two points. However, the converse may also be true. If the goal was an unbroken symmetrical blunt edge, the points may have been the incidental by-products.

<u>Sharp edge characteristics vs. some conventional morphological categories</u>. -- To further explore the modalities for sharp edge characteristics, preferences for smoothness and straightness were examined for some conventional categories of two-pointed items. If blunt edge variation is broken down further for two-pointed items without regard to symmetry, the following

distribution is obtained (Table 12).

TABLE 12

CONVENTIONAL CATEGORIES OF TWO-POINTED ITEMS

	f	%
Crescents	79	65.3
Triangles	13	10.7
Trapezoids	19	15.7
Blades	2	1.6
Asym (cres + earred)	8	6.6
Total	121[1]	100.0

[1]does not include four items which had broken sharp edges

When the preferences of the above categories for a smooth sharp edge are examined, the frequency distributions of shapes remain about the same (Table 13). When the proportions of smooth and irregular sharp edges are figured within the conventional categories, there is also little that is striking (Table 14). Three categories seem to show a preference for either a smooth or irregular sharp edge, but two of these have too few items in them to attach much significance to the percentages. The preference of trapezoids for smooth edges may be meaningful, but X^2 analysis showed a probability of 0.5 - 0.3 for accidental association of these variables.

TABLE 13

DISTRIBUTION OF CONVENTIONAL CATEGORIES OF TWO-POINTED ITEMS WITH SMOOTH AND SINUOUS SHARP EDGES

	Smooth Sharp Edge		Sinuous Sharp Edge	
	f	%	f	%
Crescents	47	63.5	32	68.0
Triangles	8	10.8	5	10.6
Trapezoids	13	17.6	6	12.8
Blades	0	0.0	2	4.3
Asym (cres + earred)	6	8.1	2	4.3
Total	74	100.0	47	100.0

TABLE 14

FREQUENCIES OF SMOOTH AND SINUOUS SHARP EDGES FOR CONVENTIONAL CATEGORIES

	Cres		Tri		Trap		Blades		cr + ear		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
Smooth	47	59.5	8	61.5	13	68.4	0	0.0	6	75.0	74	61.2
Sinuous	32	40.5	5	38.5	6	31.6	2	100	2	25.0	47	38.8
Total	79	100.0	13	100.0	19	100.0	2	100.0	8	100.0	121	100.0

If edge regularity is examined for an expanded list of blunt edge variation including one-pointed and no-pointed items, the distribution seen in Table 15 is obtained. In the expanded list, five categories seem to show a high preference for smooth edges, but again, only trapezoids and, in this list, Asym (cres + circ) pieces involve a sufficient number of items. X^2 analysis showed a probability of 0.7 - 0.5 for accidental association of these variables.

TABLE 15

SMOOTH VS. SINUOUS EDGES
AMONG ALL CONVENTIONAL CATEGORIES

	Smooth		Sinuous		Total	
	f	%	f	%	f	%
Crescents	37	53.6	32	46.4	69	100.0
Triangles	6	54.5	5	45.5	11	100.0
Trapezoids	11	64.7	6	35.3	17	100.0
Circular	4	66.7	2	33.3	6	100.0
Blades	34	56.7	26	43.3	60	100.0
(cres + earred)	6	75.0	2	25.0	8	100.0
(cres + circ)	13	76.5	4	23.5	17	100.0
(circ + earred)	2	100.0	0	0.0	2	100.0
Total	113		77		190	100.0

When edge straightness was compared to conventional types of two-pointed items, there were no marked preferences displayed (Table 16).

TABLE 16

PREFERENCE OF TWO-POINTED ITEMS FOR STRAIGHT EDGES

	Straight		Convex		Concave		Total	
	f	%	f	%	f	%	f	%
Crescents	43	54.4	23	29.1	13	16.5	79	100.0
Triangles	9	69.2	4	30.8	0	0.0	13	100.0
Trapezoids	15	78.9	3	15.8	1	5.3	19	100.0
(cres+earred)	4	50.0	3	37.5	1	12.5	8	100.0
Curved Back	1	50.0	1	50.0	0	0.0	2	100.0
Total	72	59.5	34	28.1	15	12.4	121	100.0

It is interesting that trapezoids again show the strongest preference for the character of the sharp edge. Although there is a percentage preference evident here for straight edges, X^2 analysis showed a probability of 0.7 - 0.5 for accidental association of these variables.

When edge straightness is compared to the expanded list of blunt edge variation, some interesting tendencies appear (Table 17). Now,

TABLE 17

PREFERENCE OF ALL CONVENTIONAL CATEGORIES FOR STRAIGHT EDGES

	Straight		Convex		Concave		Total	
	f	%	f	%	f	%	f	%
Crescents	43	54.4	23	29.1	13	16.5	79	100.0
Triangle	9	69.2	4	30.8	0	0.0	13	100.0
Trapezoids	15	78.9	3	15.8	1	5.3	19	100.0
Circular	2	28.5	0	0.0	5	71.4	7	100.0
Blades	36	56.3	26	40.6	2	3.1	64	100.0
(cres+earred)	4	50.0	3	37.5	1	12.5	8	100.0
(cres+circ)	14	70.0	1	5.0	5	25.0	20	100.0
(circ+earred)	1	50.0	0	0.0	1	50.0	2	100.0
Total	124	58.5	60	28.3	28	13.2	212	100.0

in addition to the marked preference of trapezoids for straight edges, Asym (cres + circ) forms show a similar marked preference. Blades and Asym (cres + earred) forms show a stronger preference for convex edges than do other categories and circular forms show a very high preference for concave edges in contrast to the general low preference for this variation. X^2 analysis shows a probability of less than 0.001 for accidental association of these variables. However, it is the discrepancy from normal tendency among the circular forms which accounts for the <u>very</u> high X^2 value. If this category is not considered, the probability for accidental association of these variables rises to 0.02 - 0.01. Interestingly, the elevation of the X^2 value can be attributed almost entirely to non-two-pointed forms. This corresponds to the weaker tendency of two-pointed forms to show preference for character of the sharp edge already noted (Tables 9, 10, and 11). Likewise, there is no real difference between symmetrical and asymmetrical two-Pointed forms to show preference for the character of the sharp edge. This difference between two-pointed items and one- and no-pointed items to influence character of the sharp edge may constitute partial evidence for a meaningful distinction between them. This distinction was also noted by Phillipson and Phillipson (1970), but in their sample, the difference was much more marked: 61% of sharp crescent edges (two-pointed) were straight versus only 28% of the "blades" (one-pointed) indicating a rather strong tendency for "blades" to have sinuous sharp edges.

Cross-section. -- The data on cross-section (Table 1) indicates first of all a strong general preference for a vertical or near-vertical back (82.7%). This high preference is reflected in all subcategories of variation in back shape. Twelve subcategories of blunt edge variation showed an equal or slightly higher preference for prismatic rather than pie-shaped cross-section. This is undoubtedly a reflection of flake production technique. Those items falling into the triangular or sub-triangular categories frequently exhibited discontinuous intentional blunting with the retouch at the ends and the middle of the back often retaining the other original flake edge.

Part 2: Dimensions

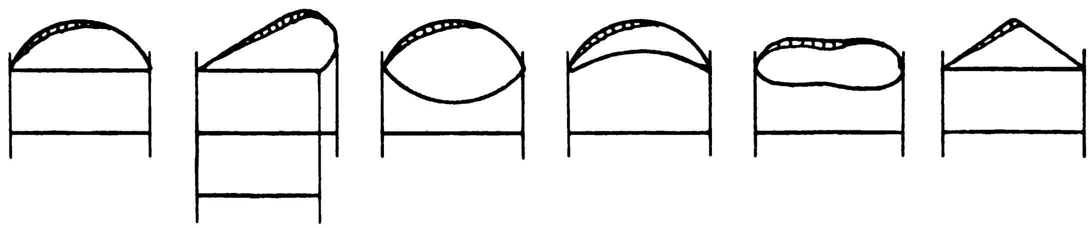
Definitions

Recording dimensions proved to be an unexpectedly difficult problem. Because of an overriding interest in attributed assumed to bear directly upon function and therefore upon traces of function, all dimensions were based upon tool axes rather than original flake axes (see Figure 8). As it turned out, flake axis was seldom apparent anyway.

Artefact length was the simplest dimension to record consistently. Length (L_1) is defined as the maximum distance parallel to the sharp natural edge. This measurement is straightforward for most items and generally corresponds to the length of the sharp edge. For items with a backed edge which curves under as it joins the sharp edge and for many curved and straight backed items, L_1 was still defined as the maximum distance, but no longer corresponds to the length of the sharp edge. If different and measureable, sharp edge length (L_2) was recorded. In cases where the sharp edge was not straight, the item was oriented to maximize balance and symmetry and a straight line imagined as nearly parallel as possible to the original flake edge. Sinuous edges were visually averaged to approximate a straight line.

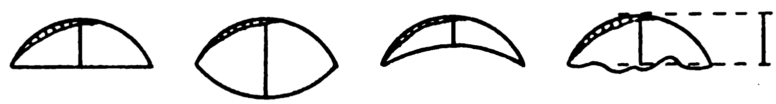
Height proved more difficult to measure consistently. Although a general definition of height as the measurement perpendicular to the length at its midpoint seemed intuitively reasonable, this proved descriptively inadequate for many items. Frequently, the height at this point was not the maximum height. Also, many items did not have straight sharp edges -- being convex, concave or sinuous. Thus, many possibilities existed for a definition of height each producing a different sort of descriptive input.

Maximum height was regarded as the most interesting of the possibilities in terms of manufacturer's intent and implications for functional requirements. In order to counteract the inherent inconsistency in this measurement, H_1 is defined as the height at the midpoint of and perpendicular to L_1l H_2 is then defined as the maximum height perpendicular to L_1.



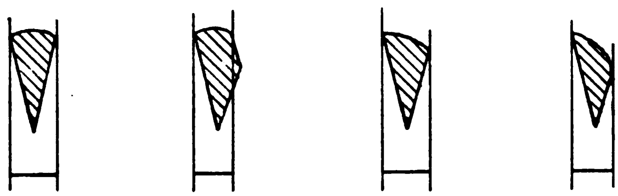
L_1: Maximum length of balanced item

L_2: Length of unretouched edge if different from L_1



H_1: Height perpendicular to L_1 at the midpoing of L_1

H_2: Maximum height perpendicular to L_1



T_1: Thickness of backed edge at intersection with H_1

T_2: Maximum thickness of backed edge

T_3: Maximum thickness of prismatic flakes

Figure 8: Visualization of Dimension Definitions

Measuring object thickness also proved not to be straightforward. For symmetrical items, maximum thickness could usually be measured at the midpoint. Significant numbers of tools, however, were not exactly symmetrical. Further, for items prismatic rather than triangular in cross-section, maximum thickness often occurred through the midline of the item rather than through the back. Since backing and hafting have been traditionally regarded as functionally related, the width of the backed edge was considered the most interesting dimension. T_1 was defined as the width of the backed edge at the midpoint (H_1) and T_2 as the maximum width of the blunted edge if different from T_1. T_3 was defined as the midline thickness of prismatic items.

General patterns of dimensional variation

It was not known at the beginning of the analysis whether this elaborate series of measurements would reveal any hitherto unsuspected or significant information about the artefacts. So little attention has been paid to dimensional variation in the past that few predictions could be made other than an upper limit of 30-35 millimeters for the length. Indeed, even in those rare cases where measurements have been taken and included as part of the assemblage description, the variation and its implications have not been carefully examined. Also, there has been very little definitional precision. A reader is frequently left to presume that figures indicate maximum dimensions but with little or no awareness of the difficulty, which I have outlined, of obtaining comparable measurements on a series of these items.

When the entire artefact sample is considered, the percentage distribution for each of the dimensions appears to be strongly modal, quite peaked, and only slightly skewed (see Table 18 and Figures 9 and 10). The characteristics of the distribution for L_1 are affected by a small number of items (7) with "extreme" values ($>$ 25 mm). Without these items, $\bar{x}$ equals 15.6 and s equals 3.3 which corresponds more closely with the obvious modality shown in Figure 9a. The percentage distribution of the ratios of L_1/H_1 and L_1/H_2 are also strongly modal. That there is little linear correlation between length and height is also demonstrated by the pattern in Figures 10 and 11.

TABLE 18

DIMENSION CHARACTERISTICS

	N[1]	Range[2]	Md	$\bar{x}$	s	Skewness	% of total range from -1s to +1s
L_1	176	7.50 - 32.50 mm	15.3	16.1	4.2	0.57	33.6
H_1	169	4.50 - 15.50 mm	8.0	8.5	2.5	0.60	45.5
H_2	230	4.50 - 15.50 mm	8.2	8.6	2.4	0.50	43.6
T_1	164	0.25 - 6.75 mm	2.8	2.9	1.3	0.20	40.0
T_2	231	0.75 - 6.75	3.4	3.4	1.2	0.00	40.0
L_1/H_1	166	0.95 - 5.35	1.8	2.05	0.77	0.97	35.0
L_1/H_2	194	0.95 - 4.65	1.8	2.01	0.71	0.89	38.4

[1]calculations are based on the total number of items for which this measurement was possible.

[2]these figures represent the midpoints of intervals

Notes on interpretation of dimensional variation

When examining the limits on dimensional variation, it is most common to do so with a model of functional requirements in mind even if the elements of this requirement-response model are not well correlated. Certainly those requirements are important here, but it is also important

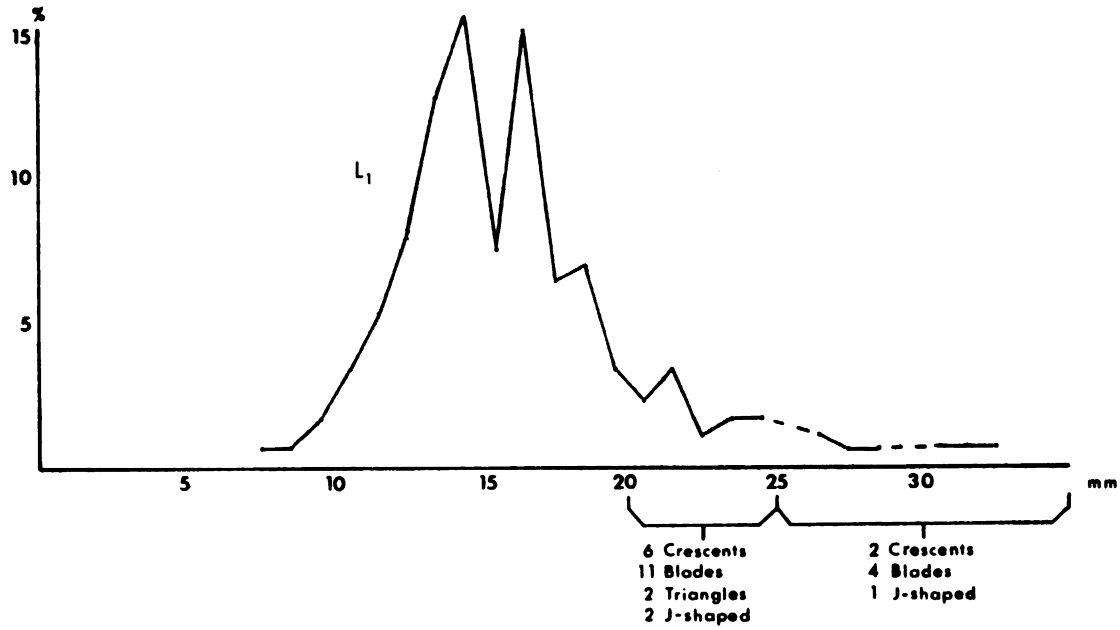


Figure 9a: Percentage Distribution for Maximum Length (L_1) (without broken items)

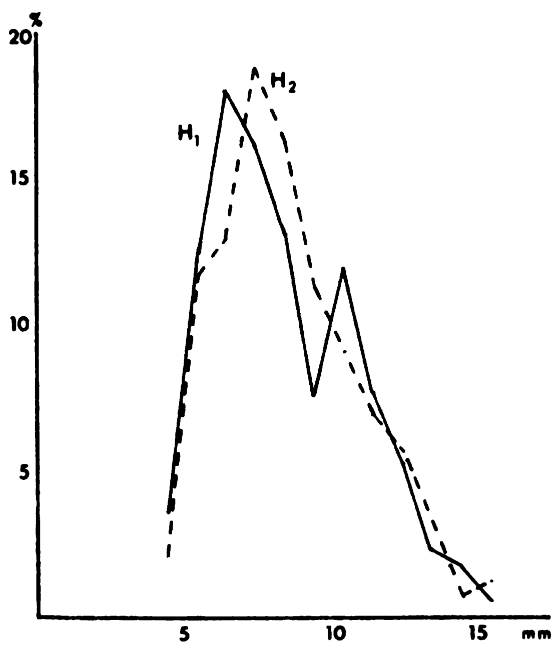


Figure 9b: Percentage Distribution for H_1 and H_2

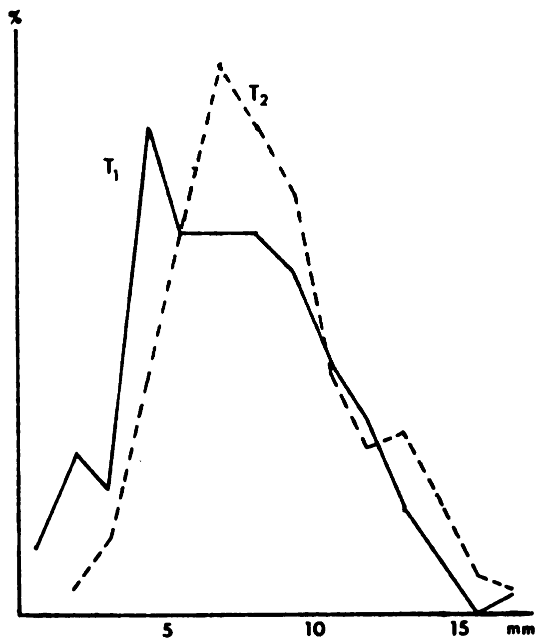


Figure 9c: Percentage Distribution for T_1 and T_2

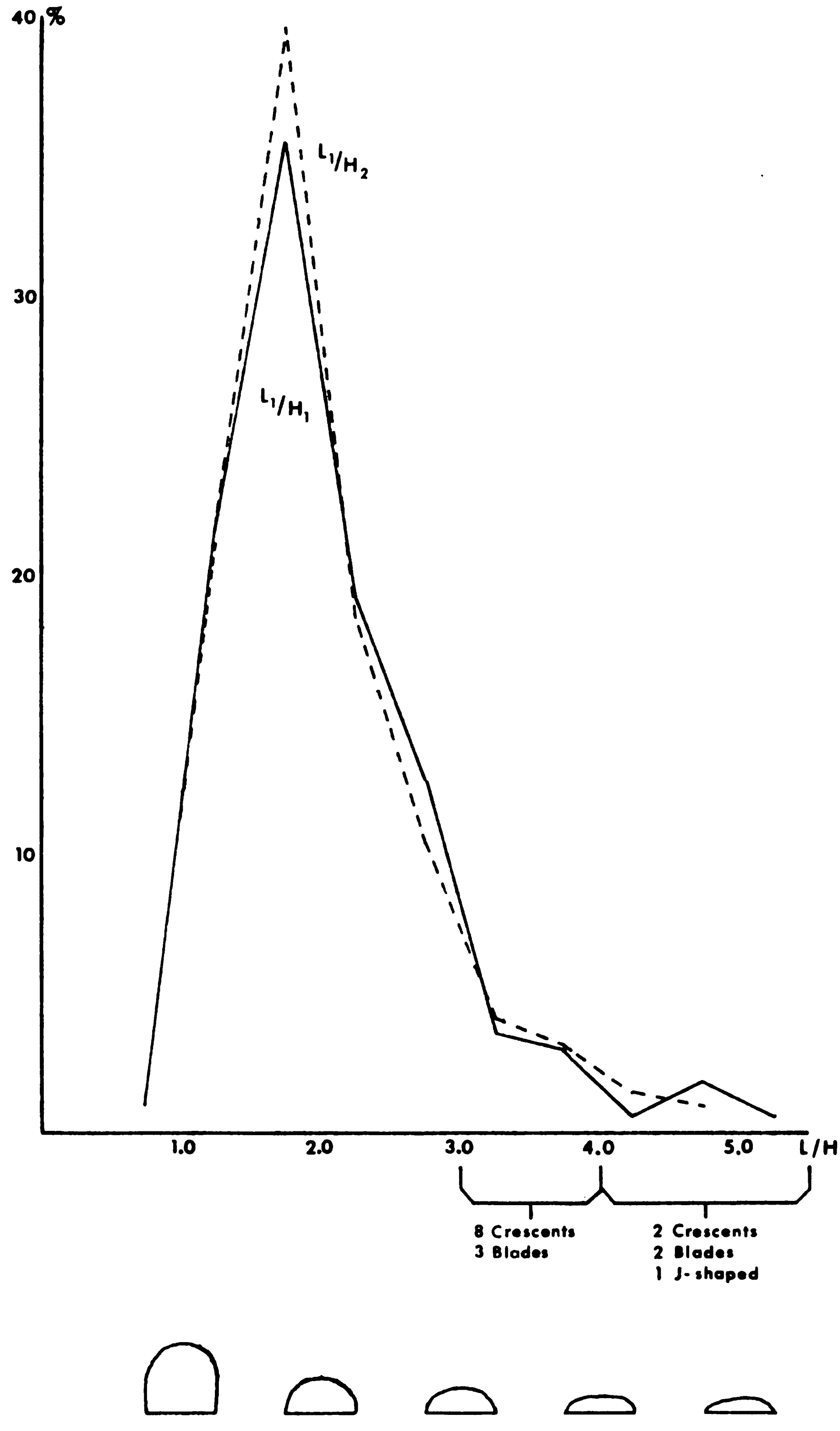


Figure 10: Percentage Distribution for L_1/H_1 and L_1/H_2

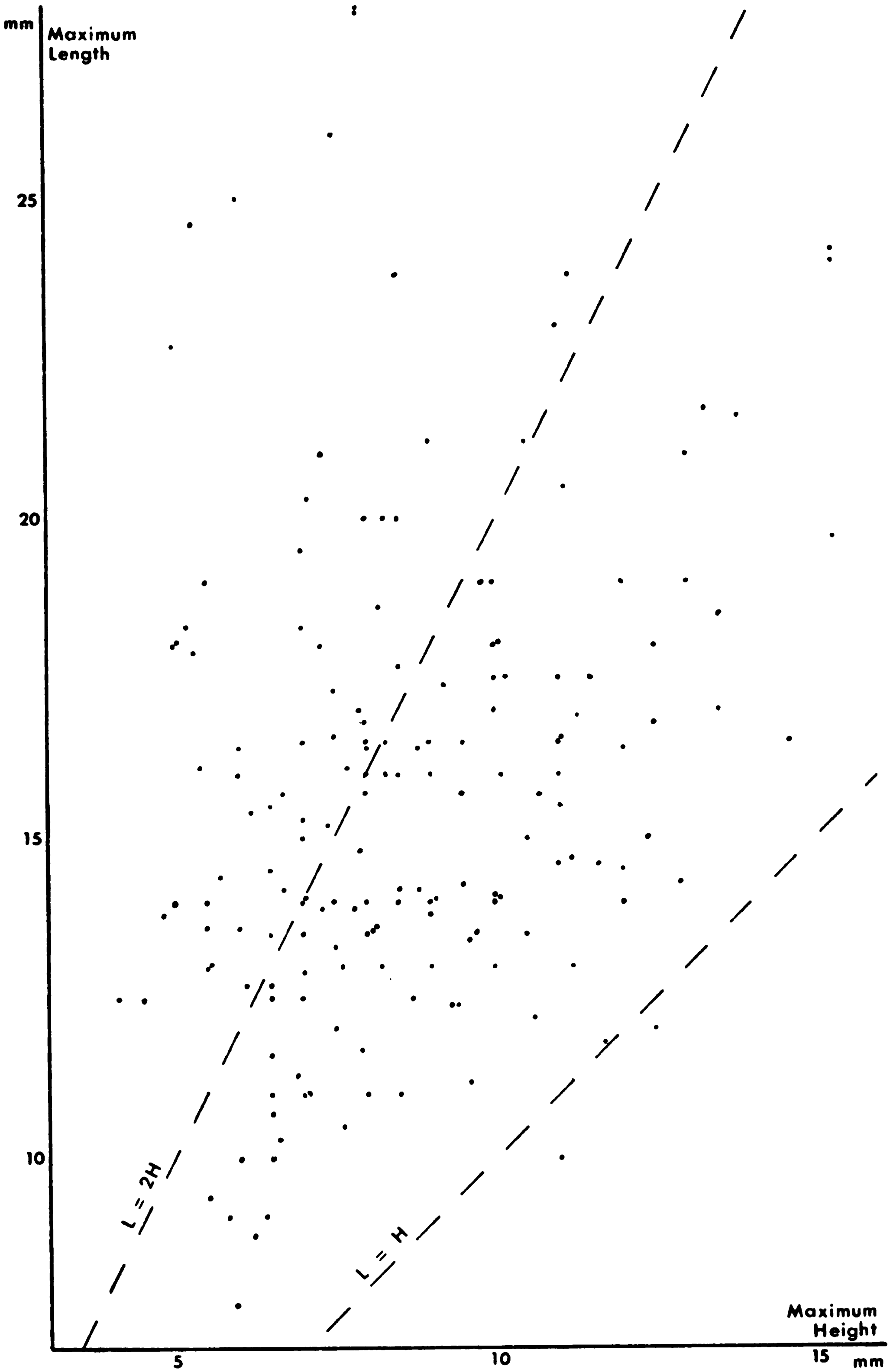


Figure 11: Scatter Diagram of Maximum Length vs. Maximum Height

to remember that, at least on the lower end of the range, size itself was its own limit. Nevertheless, even the very smallest of these items was carefully shaped.

In any case, the interpretation of the dimensional variation of items this small is not easy. The curve for L_1 (Figure 9a) has two peaks that are strongly marked. However, it would be difficult without other evidence to justify the conclusion that a meaningful difference exists between items 14.5 mm long and items 16.5 mm long. The problem does not become much simpler if the distributions for the categories of blunt edge variation are examined. Several categories have by far too few items for confident conclusions to be drawn (e.g., Asym (earred + circ) = 1, Asym (cres + earred) = 7, Circular = 7, Triangles = 11, and Straight Backed pieces = 10). In fact, none of the categories (except possibly Symmetrical Crescents with 51) contains enough pieces for confidence about the significance of differences between 1 mm intervals. The problem is the same one encountered in trying to impose limits on symmetry and edge shape. Determining the manufacturer's tolerances might be possible with a technique similar to that used by Isaac (1967) to examine edge variation, but all the logistical and interpretational problems of explaining the nature of variation are more complex here because of the small size. Controlling for variation related to factors other than human selection would be most important and difficult.

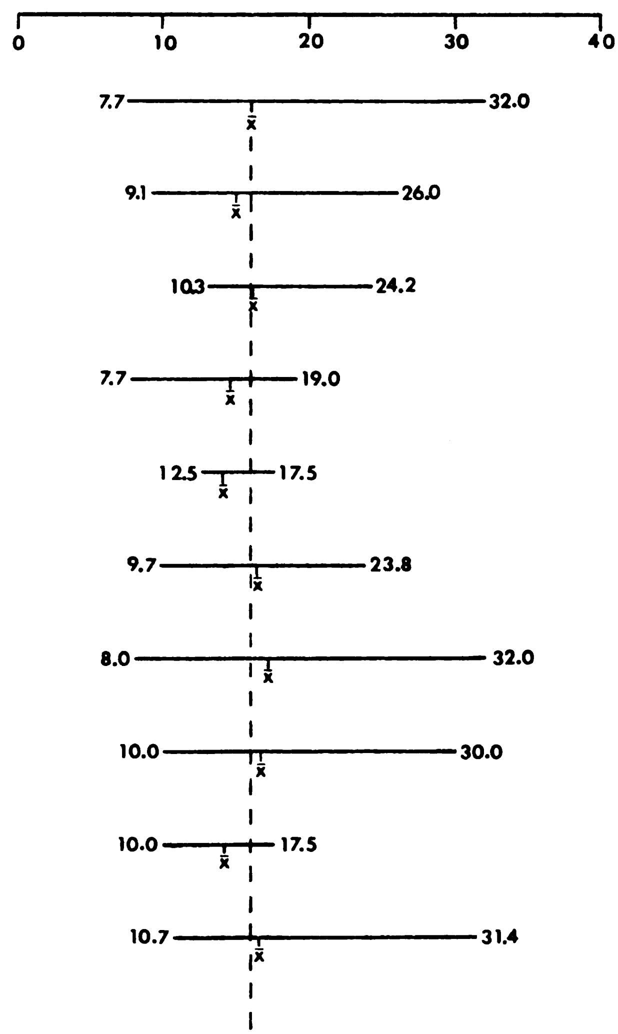
It is extremely difficult to formulate a set of expectations about the variation in dimensions of microliths. If one assumes, as many do, that they were hafted, there are several possible ways this could have been done -- at oblique angles to the haft to form barbs, parallel to the haft to expose either the sharp edge or a blunt edge, even at the end of a haft to expose either a sharp edge, blunt edge or point. Each of these models, with subvariations of hafting items singly or in series, would lead to different expectations about dimensions and relationships of dimensions. It is, of course, also perfectly possible that they were not hafted at all or perhaps only some of the time, and that different types were hafted in different ways. The result was that data gathering here had basically an exploratory format with most data collected because of possible rather than expected relevance.

Aspects of variation in length

Figure 12 shows the ranges and distribution characteristics for length of each of the subcategories of backed edge variation. A simple, two-tailed difference of means test was used to compare length variation for several categories of shape variation, the null hypothesis being that there was no difference between samples. The first step was to compare a series of shapes which seem to be related when visually assessed. One group of these are what I have called two-pointed items. Various typological definitions aside, in practice, many items seemed to fall midway between pairs of these traditionally recognized categories. They do not form a series as many have suggested, but rather a constellation of apparently interrelated forms (see Figure 13).

If the percentage distributions of length variation for these subsamples are simply graphed, they still seem to be but aspects of the same pattern (see Figure 14). Using the two-tailed difference of means test, the impression of similarity is reinforced. The null hypothesis could not be rejected even at the 0.05 level of significance for any set of pairs (see Table 19).

Range in Millimeters



	N	$\bar{x}$	s
Total Sample	202	16.0	4.2
Sym Cres	51	14.9	3.3
Triangles	11	16.1	3.8
Trapezoids	17	14.6	3.0
Circular	7	14.0	1.8
Straight Back	17	16.4	3.6
Curved Back	47	17.1	5.1
Asym (cres+cres)	23	16.6	4.6
Asym (cres+ear) & reverse	7	14.2	2.6
Asym (cres+circ) & reverse	21	16.5	4.5

Figure 12: Ranges and Characteristics of L_1 Distributions

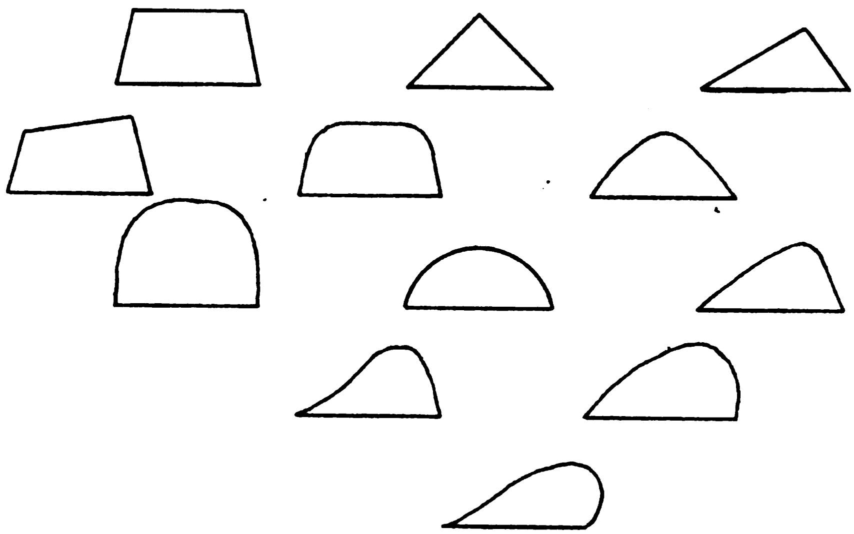


Figure 13: Shape Variation Among Two-Pointed Items

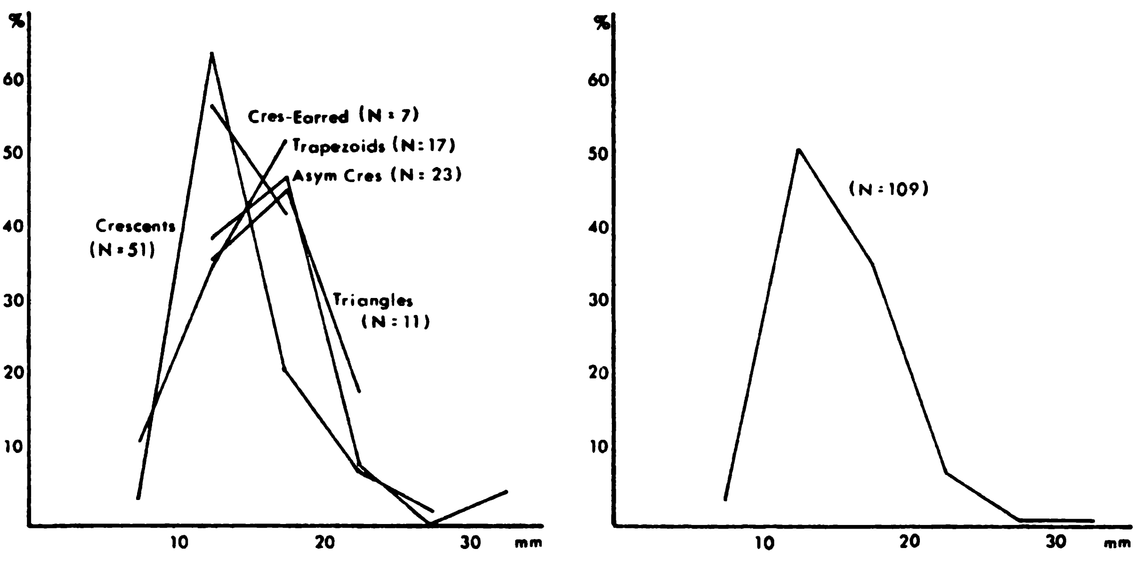


Figure 14: Percentage Distributions of L_1 for Sub-Categories of Two-Pointed Items

TABLE 19

RESULTS OF DIFFERENCE OF MEANS TESTS FOR LENGTH VARIATION OF TWO-POINTED ITEMS

Compared Categories	N	Probability that H_0 is Correct
Sym Crescents to Triangles	51/11	0.4 to 0.3
Sym Crescents to Trapezoids	51/17	0.8 to 0.7
Sym Crescents to (cres + cres)	51/23	0.1 to 0.5[1]
Sym Crescents to (cres + earred)	51/7	0.7 to 0.6
Triangles to Trapezoids	11/17	0.4 to 0.3
Triangles to (cres + cres)	11/23	0.8 to 0.7
Triangles to (cres + earred)	11/7	0.3 to 0.2
Trapezoids to (cres + cres)	17/23	0.2 to 0.1
Trapezoids to (cres + earred)	17/7	0.8 to 0.7
(cres + cres) to (cres + earred)	23/7	> 0.9

[1]unexpectedly low

Even though the null hypothesis could not be rejected, the probability of no difference between symmetrical and asymmetrical crescents is unexpectedly low. This is precisely the opposite of what might be expected of these two categories on the basis of shape.

Gratifyingly enough, when the tests are extended to other shape categories for which differences might logically be predicted, expectations are fulfilled. The problem of classifying blades has already been discussed (p. 28 and 34). As mentioned above, standard definitions of backed blades usually subsume pieces with one or two snaps perpendicular to the length axis with no presumption that these might be broken rather than whole items. When the difference of means test was applied to "backed blades," marked dissimilarities were revealed (see Table 20 and Figure 15).

TABLE 20

RESULTS OF DIFFERENCE OF MEANS TEST FOR LENGTH VARIATION OF "BACKED BLADES"

Compared Categories	N	Probability of No Difference
Whole Straight Backed Pieces vs. Straight Backed Pieces with Snaps	10/7	0.02 - 0.01
Whole Curved Back Pieces vs. Curved Back Pieces with Snaps	28/19	0.05 - 0.02
Whole Straight Backed Pieces vs. Whole Curved Back Pieces	10/28	0.60 - 0.50
Straight Backed Pieces with Snaps vs. Curved Back Pieces with Snaps	7/19	>0.90
All Whole Pieces vs. All Broken Pieces	38/26	0.01 - 0.001

The implications are clear. In this sample, pieces with snaps are different from those without snaps. This places strong doubt on the commonly held assumption that these snaps were fortuitous or intentionally produced for inclusion in the final shape of the items. Or, if they were intentionally included and these are not broken items, this raises the possibility that a separate category with a different set of presumed functional requirements should be created for pieces truncated by snaps.

The very strong similarity between snapped straight backed pieces and snapped curved back pieces suggests another interesting hypothesis. If one assumes that these pieces were hafted and that these are <u>broken</u>

tools, the great similarity of length variation could be attributed to a minimum depth of efficient insertion in the haft or, a minimally efficient grip with the fingers.

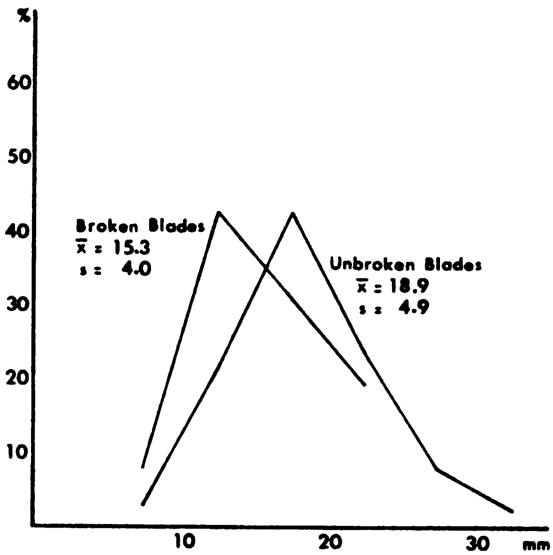


Figure 15: Length Variation for Broken vs. Unbroken Backed Blades

When unbroken backed blades, which are predominantly single pointed items are compared to J-shaped items (also single pointed), at first the similarity seemed strong (see Figure 16). However, the difference of means test showed a very low probability that there was no difference between these items (P = 0.1 to 0.05). There are few morphological extensions to this apparent difference in length variation.

When all the two-pointed items are compared to all the one-pointed items, the differences are very marked (see Figure 17) and the probability of no difference (P = 0.01 to 0.001) confirms this.

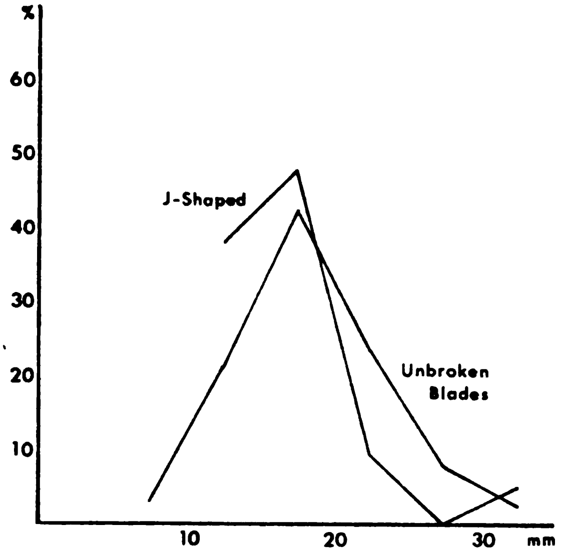


Figure 16: Length Variation for J-Shaped vs. Unbroken Blades

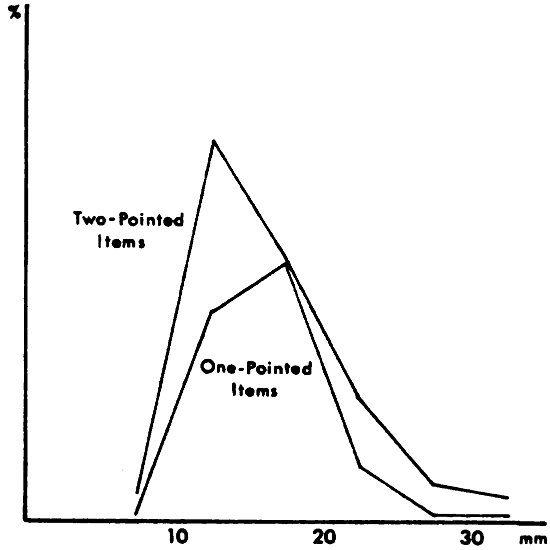


Figure 17: Length Variation for Two-Pointed vs. One-Pointed Items

Aspects of variation in height

Intuitively, height variation might be expected to show very strong evidence of control by the manufacturer. First of all, height is subject to constant control because it always involves a retouched edge. Several of the possible models for hafting or gripping would also predict an emphasis on height control. The characteristics of the distributions of H_1 and H_2 do show a high degree of control (Table 18 and Figure 9b), but not higher than upon other dimensions at this level. Figure 18 shows the ranges and characteristics of the distributions of H_1 and H_2 for the conventional shape categories.

When two-pointed items were tested for internal consistency of variation in H_2, the results were equivocal. Several pairs of categories showed low probabilities that there was no difference between the pairs (see Table 21). However, when broken and unbroken blades were compared, the probability of no difference was very high (see Table 22) in contrast to the test upon length variation.

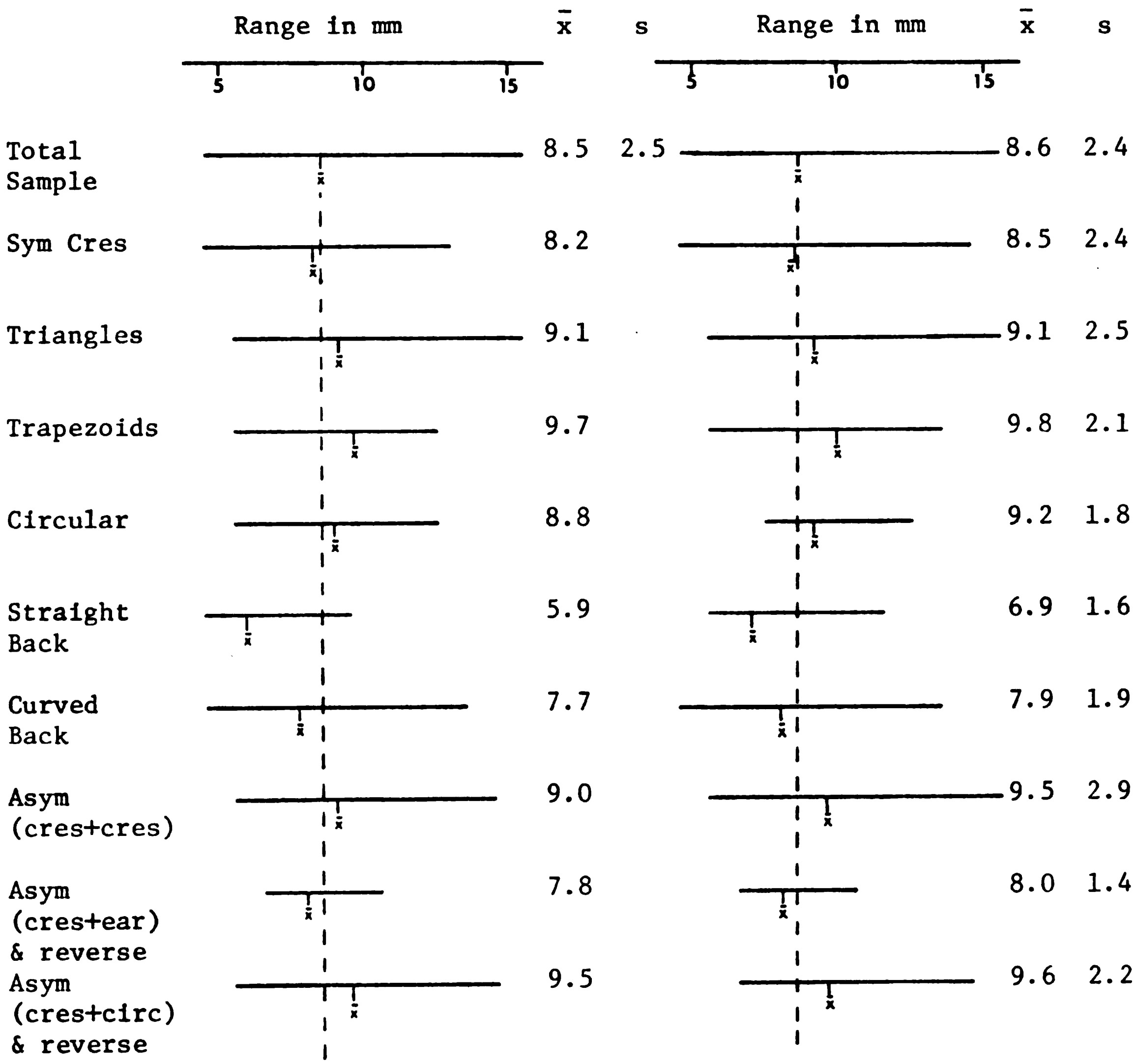


Figure 18: Ranges and Characteristics of Distributions of H_1 and H_2

TABLE 21

RESULTS OF DIFFERENCE OF MEANS TEST FOR HEIGHT VARIATION OF TWO-POINTED ITEMS

Compared Categories	N	Probability of No Difference
Symmetrical Crescents vs. Triangles	73/12	0.50 to 0.40
Symmetrical Crescents vs. Trapezoids	73/19	0.05 to 0.02[1]
Symmetrical Crescents vs. Asym (cres + cres)	73/24	0.10[1]
Symmetrical Crescents vs. Asym (cres + earred)	73/8	0.60 to 0.50
Triangles vs. Trapezoids	12/19	0.90
Triangles vs. Asym (cres + cres)	12/24	0.70 to 0.60
Triangles vs. Asym (cres + earred)	12/8	0.30
Trapezoids vs. Asym (cres + cres)	19/24	0.80 to 0.70
Trapezoids vs. Asym (cres + earred)	19/8	0.05 to 0.02[1]
Asym (cres + cres) vs. Asym (cres + earred)	24/8	0.20 to 0.10

[1]low probabilities indicate possible difference between categories

TABLE 22

RESULTS OF DIFFERENCE OF MEANS TEST FOR
HEIGHT VARIATION OF WHOLE VS. BROKEN BLADES

Compared Categories	N	Probability of No Difference
Whole Straight Backed Blades vs. Broken Straight Backed Blades	6/11	0.90
Whole Curved Back Blades vs. Broken Curved Back Blades	29/17	0.90

Likewise, when two-pointed items were compared to one-pointed items, the probability of no difference between samples was also 0.90. The equivocal results of tests upon variation in height are difficult to interpret. For two-pointed items, it is possible that length rather than height was the critically controlled dimension. Again, it is interesting that the characteristics of variation in height for symmetrical and asymmetrical crescents are as dissimilar as for length. For backed blades, the similarity of height parameter of snapped and unsnapped pieces seems to support the hypothesis that blades with snaps are really broken blades.

Figure 9b shows the distribution of H_1 to be very similar to H_2. Of course, for many items H_1 and H_2 were identical. In other words, maximum height (H_2) frequently occurred at the midpoint of the item and coincided with H_1. However, all of the shape categories, even those inherently symmetrical, contained items with the maximum height occurring other than at the midpoint. The explanation is that, for all categories, the average difference between H_1 and H_2 was less than 1 millimeter (see Table 23), a difficult difference to assess visually.

Thirty-three percent of the two-pointed items and 62.5% of the one-pointed items showed the maximum height to be somewhere other than exactly at the midpoint.

TABLE 23

AVERAGE DIFFERENCE BETWEEN H_1 AND H_2 ON ITEMS WITH MAXIMUM HEIGHT NOT AT MIDPOINT

Category	Average Difference Between H_1 and H_2	N
Symmetrical crescents	0.8 mm	13
Triangles (sym and asym)	0.5 mm	2
Trapezoids	0.6 mm	7
Asym (cres + cres)	0.7 mm	11
Asym (cres + earred)	0.3 mm	2
Asym (cres + circ)	0.9 mm	8
Circular	1.0 mm	3
Unbroken Straight Backed Blades	0.8 mm	6
Unbroken Curved Back Blades	0.6 mm	21

Aspects of variation in the ratio of length to height

Figure 10 and Table 18 show a strong preference among these tools for a certain length to height ratio. This distribution may be somewhat misleading, however, if taken at face value. The morphological difference between items with a L/H value between 1.0 and 2.0 is considerably greater than between items with values between 2.0 and 5.0 (see Figure 19).

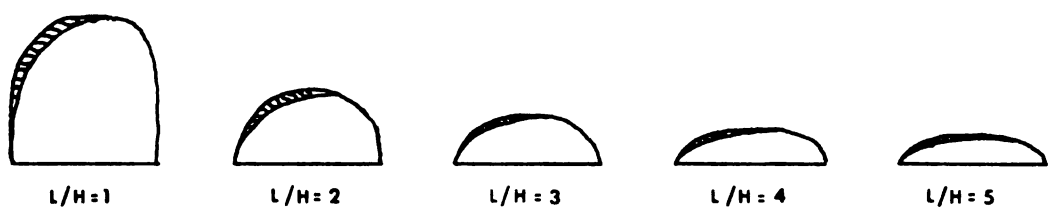


Figure 19: Visualization of Changes in Height for Items of the Same Length

Other aspects of the L/H pattern are revealed if L/H is plotted against L. Figure 20 shows the distribution for the entire sample. Obviously, by far the majority of items cluster about the intersection of the two means. It is also clear that the scattering of items beyond this cluster (L/H > 3.5 and L > 25 millimeters) skews these means slightly and it is these items about which one might legitimately question the functional or typological similarity. Nelson (1970) notes a tendency for "crescents" from Nsongezi to be narrow if they are long, and high if they are short. The same tendency is seen here even more clearly. However, due to the expanding nature of the display, the shorter, broader items are not isolated from the main cluster as are the longer and narrower items.

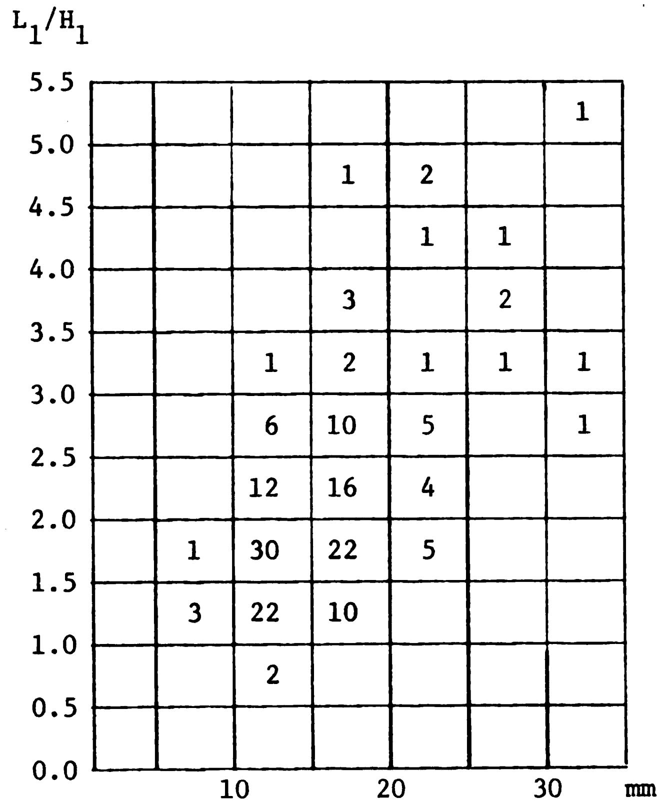


Figure 20: L_1/H_1 vs. L_1

A plot of two-pointed items shows very tight clustering with a very small number of items which do not conform to the pattern (see Figure 21). One-pointed items by contrast have a dispersed pattern (see Figure 22). One possible explanation of these patterns is that dimensional control was more important for two-pointed items than for one-pointed items. It may indicate that some other attribute was being controlled on one-pointed items. One-pointed items were shown, for example, to display slightly more marked preferences for smooth, straight edges (p. 45 above), but the emphasis could just as well have been on the point itself, to which there would be few morphological clues.

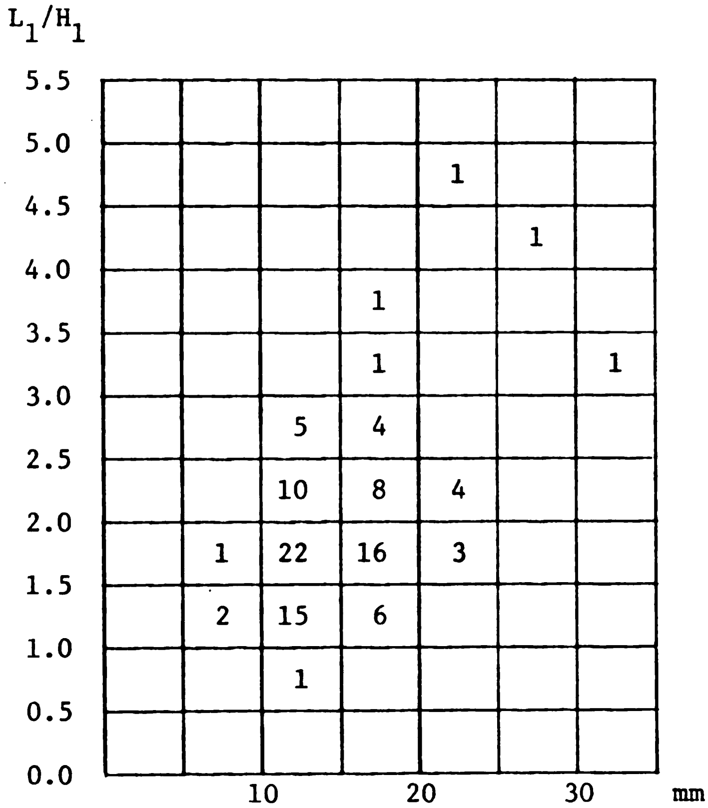


Figure 21: L_1/H_1 vs. L_1 for Two-Pointed Items

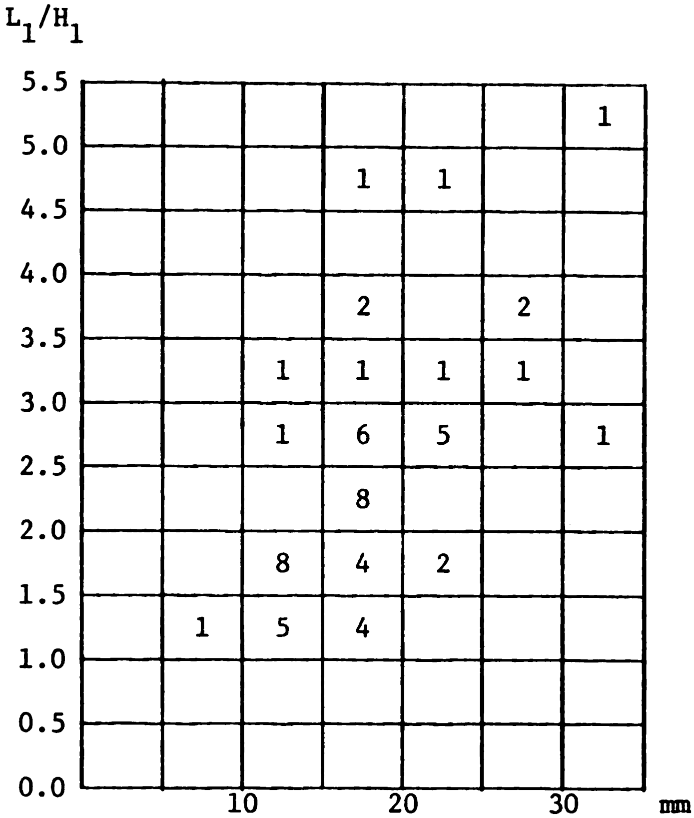


Figure 22: L_1/H_1 vs. L_1 for One-Pointed Items

Aspects of variation in thickness

The maximum thickness of the blunted back occurred at a point other than the midpoint on 70% of the items (see Table 21). It would be logical to expect this for backed blades and J-shaped items which frequently preserved the bulb of percussion or traces of it, but, in fact, all shape categories showed this high percentage. This variation is undoubtedly related to original flake characteristics and the unsophisticated and uneven quality of flake production for tool manufacture, evidenced by the enormous quantity of waste at Later Stone Age sites.

TABLE 24

MAXIMUM THICKNESS MINUS MIDPOINT THICKNESS

	$T_2 \neq T_1$		$T_2 - T_1$	
Category	N	%	Mean Diff.	Range of Diff.
Symmetrical crescents	37	68.5	0.7	0.1 - 2.5 mm
Triangles	7	63.6	0.9	0.1 - 1.9 mm
Trapezoids	15	83.3	0.9	0.4 - 3.1 mm
Circular	5	71.4	1.0	0.3 - 1.9 mm
Asym (cres + cres)	16	69.6	0.7	0.1 - 1.6 mm
Asym (circ + earred)	3	42.9	1.3	0.4 - 2.1 mm
Asym (circ + cres)	14	70.0	1.3	0.1 - 2.6 mm
Asym (circ + earred)	2	100.0	0.8	0.3 - 1.3 mm
Straight Back Blades	4	57.1	0.8	0.2 - 1.5 mm
Curved Back Blades	23	74.2	0.7	0.2 - 2.0 mm
Total	126	70.0	0.8	0.1 - 3.1 mm

Even though it seems reasonable to attribute a good deal of variation in tool thickness to original flake characteristics, there were some tendencies which seemed to indicate the influence of choice. When back width (T_1) of one-pointed items was compared to that of two-pointed items, the statistical parameters of variation were very similar, but the actual distributions give a different impression (see Figure 23). Here it is clear that one-pointed items have a strong tendency to be thin -- 1-2 millimeters -- at T_1. Two-pointed items have a much wider tolerance for variation at this location -- 1-4 millimeters -- with items distributed equally over this range. The relationship of the few one-pointed items more than 3.5 millimeters thick at T_1 to the larger cluster below 3.5 millimeters is not clear here. These thick one-pointed items tended to be long ($\bar{x}$ = 19.6 millimeters), twice as long as high (l_1/H_1 = 2.1), and twice as high as thick (H_1/T_1 = 2.2). Figure 24 shows the distribution of H_1/T_1 for one- and two-pointed items plotted against H_1. There is a tendency for one-pointed items to be narrower and thinner in relation to height than two-pointed items.

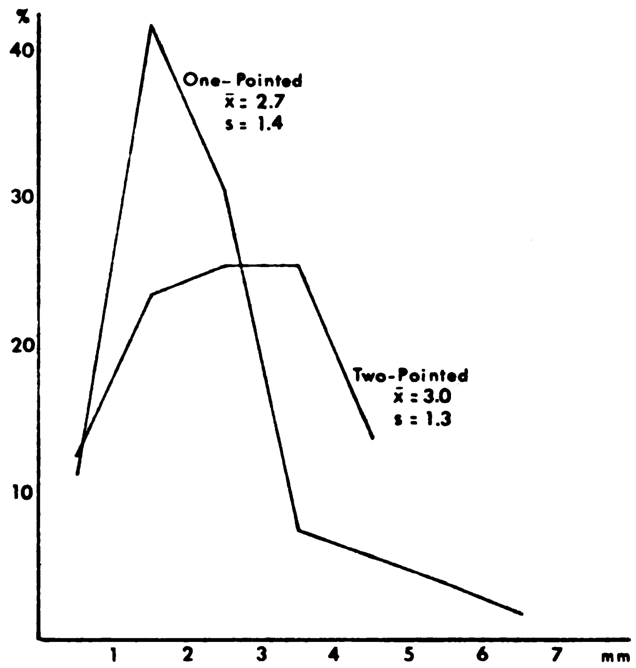


Figure 23: Percentage Distribution for T_1; Two-Pointed vs. One-Pointed Items

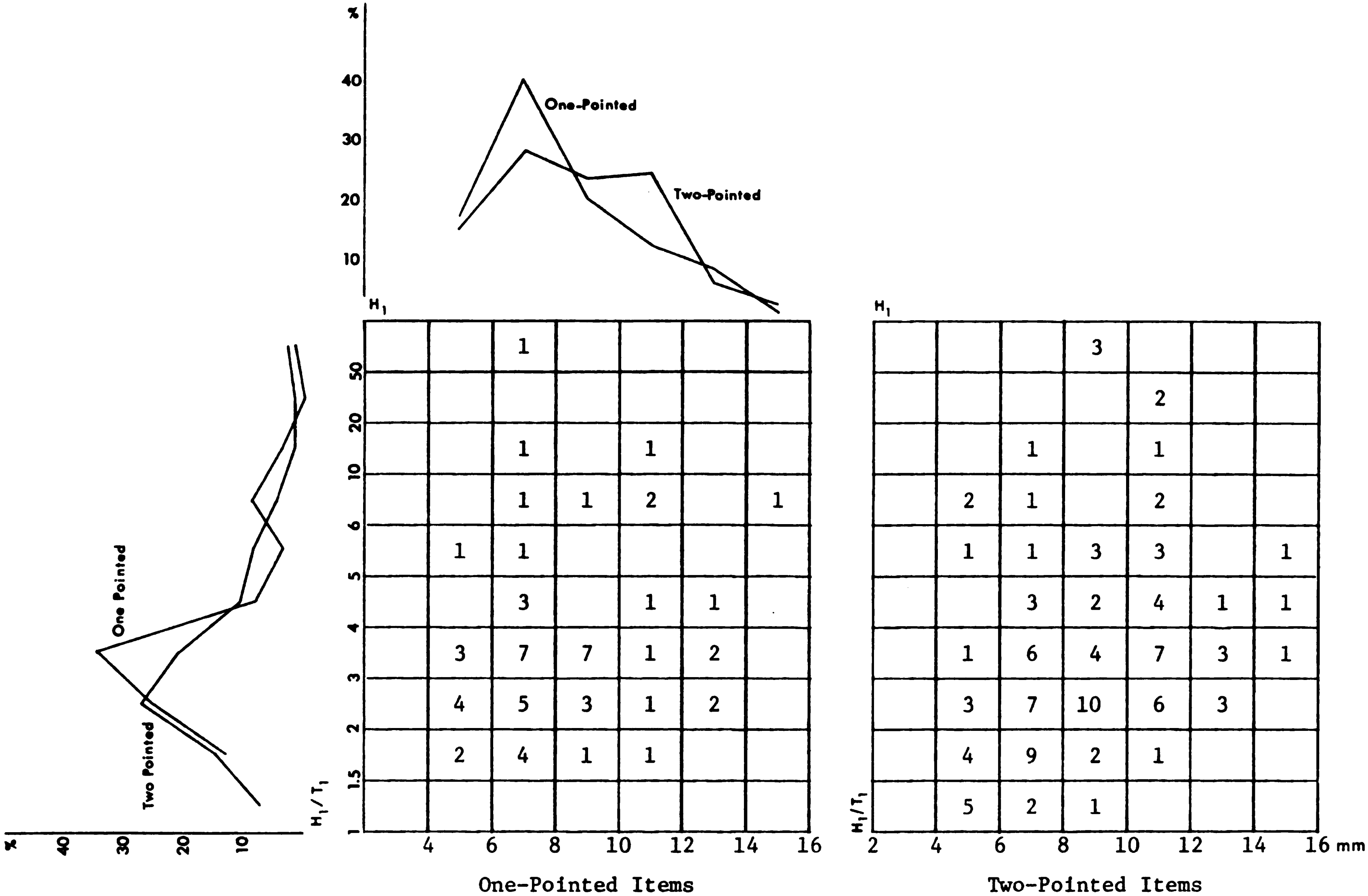


Figure 24: H_1/T_1 vs. H_1 for One- and Two-Pointed Items

CHAPTER V

ANALYSIS OF DAMAGE

Introduction

The problems in microscopic wear and damage anaylsis nearly outnumber the benefits. Preservation and character of traces of wear depend upon material hardness as well as utilization of sufficient duration to produce a characteristic pattern. Weathering and abuse, both contemporary and subsequent to utilization may obscure traces related to function. Multifunctional utilization patterns, resharpening and reshaping all may add to pattern complexity. Analysis is extremely time consuming and requires special equipment. Certain kinds of raw materials, such as vein or crystalline quartz, refract and reflect light so as to make examination and photography nearly impossible without special coating techniques.

An extremely useful article by Keeley (1974) surveys the majority of reports published in "principle Western journals" which have devoted any time or space at all to microwear analysis. Although virtually no study exists at present against which serious criticisms cannot be leveled, a very few do succeed principally because their authors were careful not to let interpretations and conclusions exceed methodological limits. Even some of these successful studies can be faulted by one of the first criticisms mentioned by Keeley, the failure to describe adequately the methods and techniques used to observe traces of utilization. Research credibility and value is predicated on more than the quantity or nature of the end product -- namely the data or new information. Every study must be evaluated in terms of its adherence to rigorous method, its replicability and its potential to provide useful approaches to new material, even if only by contrast. Thus the failure to carefully describe all laboratory procedures is quite serious. To this I would add that this still very new kind of research is beset by myriad small logistical problems not directly related to actually seeing the traces of utilization through the microscope. Thus the failure to document the successes and failures, the advantages and disadvantages of the methods used to observe, record, analyse and display information is also very serious. This relates directly to another of the criticisms leveled by Keeley -- the general failure to quantify data. Data can be quantified only if it is recorded in such a way that it can be retrieved again and summarized.

Unfortunately, it is not common to find expertise in microscopy, photography, chemistry and quantitative methods neatly packaged in one archeologist with a yen to see use-wear on his or her artefacts. This, and the difficulty of access to the required sophisticated equipment, accounts for most of the serious failures of microwear studies. Keeley mentions the necessity of high magnification, but few archeologists have enough expertise to anticipate and overcome the problems of fixed stage microscopes and thin depths of field. Likewise the decision of whether to use microphotography or macrophotography may be based on lack of knowledge or lack of equipment rather than the actual advantages or disadvantages of either. Because of this, the failure to carefully describe method is all the more serious. It fosters random and idiosyncratic rather than regular progress. It means that a great deal of work that is contemplated or even begun will never be completed or published because the worker could not overcome unanticipated problems concealed or glossed over by other studies.

The problem of microwear studies listed by Keeley apply also to this study. I have tried to describe as fully as possible the methods and techniques used to observe, record, summarize and display the data about morphology and damage, including those which turned out to be less than satisfactory. Other problems were more difficult to resolve and constitute serious drawbacks. For example, there was a large number of items suitable for examination and analysis (219) and all of these were included in the analysis of morphology and macro-damage, but only 40 were ultimately subjected to microscopic examination.

Additionally, a consideration of all the possible causes of macro- and micro-damage was hampered by several factors. In general, not much is known about the details of the economies or site activities of Post-Pleistocene groups or cultures of East Africa. In other places where preservation of organic artefacts, especially wood, is better, more inferences may be made and also ethnographic comparisons. In terms of this particular site, the principle difficulty is that the entire assemblage has not been analyzed. This and other problems (described in Chapter II) have made it necessary to rely primarily on what is known or inferred about other sites for interpretation of the data accumulated about these items.

When this study was initiated, I knew next to nothing about the problems and requisites of microwear analysis. Too late to back out, the realization dawned that the history of this assemblage made it a very bad candidate for a microwear analysis. In addition to all the problems mentioned above, the artefacts had been subjected to an inordinate amount of physical abuse during and subsequent to excavation -- including beeing screened, packed and shipped in bulk lots in bags, and, finally, being subjected to a series of handlings in the laboratory for various reasons, including my own sorting out of items suitable for inclusion in this study. Although the agents affecting the damage to these artefacts are known and so in Keeley's sense may be "controlled", their weight places a considerable burden on this analysis.

No replicative experiments were performed. Most questions specific enough to warrant replicative experiments were not formulated until the analysis was largely complete. Not incidentally, gaining the expertise needed for fabrication of duplicate tools and design of experiments would have required an additional expenditure of time not feasible here. Fortunately in this regard, and in regard to other problems already discussed, an extremely rigorous and successful microwear analysis of a Later Stone Age assemblage from Zambia came to my attention in the latter stages of this research. This report, by Phillipson and Phillipson (1970) holds up extremely well against all the criticisms discussed by Keeley, including providing an elaborate, carefully drawn "framework" (in Keeley's sense) of replicative experiments, ecological and archeological context, as well as association and comparison with other artefact forms. Their study provides much of the basis for evaluation of data accumulated here.

Analytic Techniques

Consistency of morphological components. -- A concerted effort was invested at the beginning of the analysis of this collection to devise some method of examining each artefact in a systematic and easily repetitive way. This was somewhat facilitated by the fact that these items displayed broad morphological similarity rather than similarity restricted to characteristics of working edge as is the case with scrapers and many other kinds of tools from other times and places. Although microliths are frequently classified by how closely they approximate crescent, triangle and trapezoid shapes, the morphological components of this variety of shapes remained constant. Every item could readily be described in terms of a blunted back and a sharp edge. Furthermore, there were the following, fairly consistent, localities: two faces and three edges formed by the intersection of the two faces or of a face and the back. These localities were coded in the following way (see Figure 21):

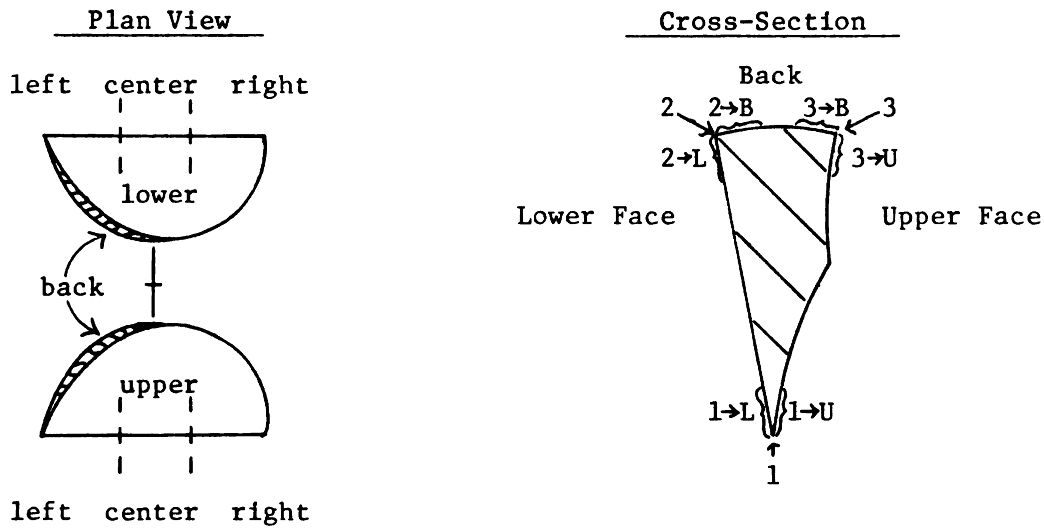


Figure 25: Visualization of Artefact Localities

The original unretouched lateral flake edge was coded #1; the intersection of the back and lower face was coded #2; and the intersection of the back and upper face, #3 (see method of standardizing orientation below). This provided nine mutually exclusive descriptive locations -- three edges and six edge-face areas. Each edge and edge-face area was further divided for recording purposes into left, center and right sections, purely as a visual aid to examination (see discussion of data recording matrix, p. 83 ff.).

Standardized orientation of artefacts. -- It became apparent early on that each item would have to be oriented somehow so that points of reference would remain constant. Orientation according to original flake features was easiest and these were used whenever possible. Frequently, however, all traces of flake orientation had been removed. For examination and description, all items were placed with the sharp edge toward the examiner and the blunted edge away. The tips were then referred to as left and right. If the ventral face of the original flake could be determined, this became the "lower" face. If the item was facetted or prismatic in cross-section, the unfacetted face became the lower face. If the cross-section was triangular (or pie-shaped) and no other features were apparent, then the flattest face became the lower face. A few items provided no features useful for orientation and were oriented arbitrarily.

Development of data recording matrix. -- One of the hoped-for benefits of establishing a rigorous method for artefact examination was the avoidance of overly general statements about the nature and location of wear or damage. Statements such as "wear seemed concentrated near the center of the working edge" only serve to beg several questions: What kind(s) of "wear?"; Is the "wear" diffuse or concentrated at a point?; What does the "wear" reveal about force and direction of use?; What indeed _is_ the "working edge" and why does the investigator think so?; Is there really _no_ wear or damage at any other location? In addition, the reverse tendency might be eliminated, namely, to make idiosyncratic descriptions of damage, item by item.

Therefore, after determining the mutually exclusive localities where damage occurred, the next step was to develop a way to record the exact location and type of damage so that visual assessment could be made of its linear distribution as well as the relationships of different types of damage occurring in various orders or superposition, such as polish over chipping. This effort was only partially successful, in that the evolution of the form of the data matrix continued throughout most of the examination and the most satisfactory format was achieved only toward the final stages. This was an unfortunate consequence of the scarcity and superficiality of work on this subject until now and the failure of those who have attempted to examine use damage to publish their procedures. Even Keeley (1974) while justifiably condeming degenerating techniques of analysis, does not deal with data recording specifically. Even the final form of the matrix was not completely satisfactory due to the enormous variety of possible questions to be asked of the data.

Given the basically linear distribution of the damage at each of the nine localities, two alternatives for recording the exact location of types of damage (chips, polish, striations, etc.) came immediately to mind. One was to record each type of damage separately, that is, to compile for the entire sample of items, the distribution of, say, striations. It would be possible to visually assess in one matrix the consistency of the distribution of striations on, for example, the upper face leading away from the sharp edge (this is locality 1→U).

The other alternative was to record all the different types of damage in one matrix, item by item. This proved the most successful. Despite the appeal of the first alternative, the actual process of microscope examination was sufficiently tortuous so as to demand the least complex and most internally reinforcing recording technique. In addition, recording all types of wear for a locality in the same place preserved linear and superpositional relationships and prevented separating types of damage produced together. Also, distributions of individual types of damage could, if desired, be abstracted later with reasonable accuracy. The reverse process, or reassembling of overlapping distributions, would definitely have been as tortuous as the original examination and considerably less accurate.

The same sized matrix was used for all items, regardless of length, height, or thickness. At first, it was not clear that standardizing the distributions of damage on all items to the same spatial limits would not result in loss of information or distortion of perception about relationships. However, the logistical problems inherent in preserving actual proportions quickly overwhelmed anxiety about this issue.

The actual size of the matrix could not be the same as the items themselves. Even the largest of these artefacts were only a little more than 30 millimeters long. The codes would have been as microscopic as the damage itself. Enlarging the matrix, but maintaining correct proportions would have been an enormous amount of work and the benefits of doing this were not clear. Also, a comfortable size matrix was 45-60 millimeters long. If this size were used for the smallest items (~7 millimeters), the matrix for the largest (~32 millimeters) would have been 200 to 270 millimeters long. This enlargement alone, ignoring the problem of contending with the variety of sizes, greatly reduces or even eliminates the possibility of visual assessment of patterns of distribution. Visual assessment is, of course, not a rigorous analytic technique. However, if one wishes to reduce the list of all possible questions to be asked about distribution patterns and relationships of types of damage to those most likely to be productive, it is indispensible.

No a priori assumptions about the location of functional areas were made, for example, points were not examined as such or apart from the edges or edge-face localities which are the components of a point. It was assumed that the matrix would reveal concentrations of damage wherever they occurred without special attention. Because of the uncertainties about function already described, I wanted the record of the distribution of damage to be as unbiased as possible. If damage were assumed to be restricted in any way, it would become all too easy to miss nonconforming patterns. The matrix eventually evolved into the form shown in Figure 26. In the end, I concluded that the exact size of the matrix is not critical as long as it is comfortable to record data within it. At the beginning of any analysis of this type, it simply cannot be known how much coded data will have to be recorded in a small space. It is best to allow as much room as one is comfortable with visually.

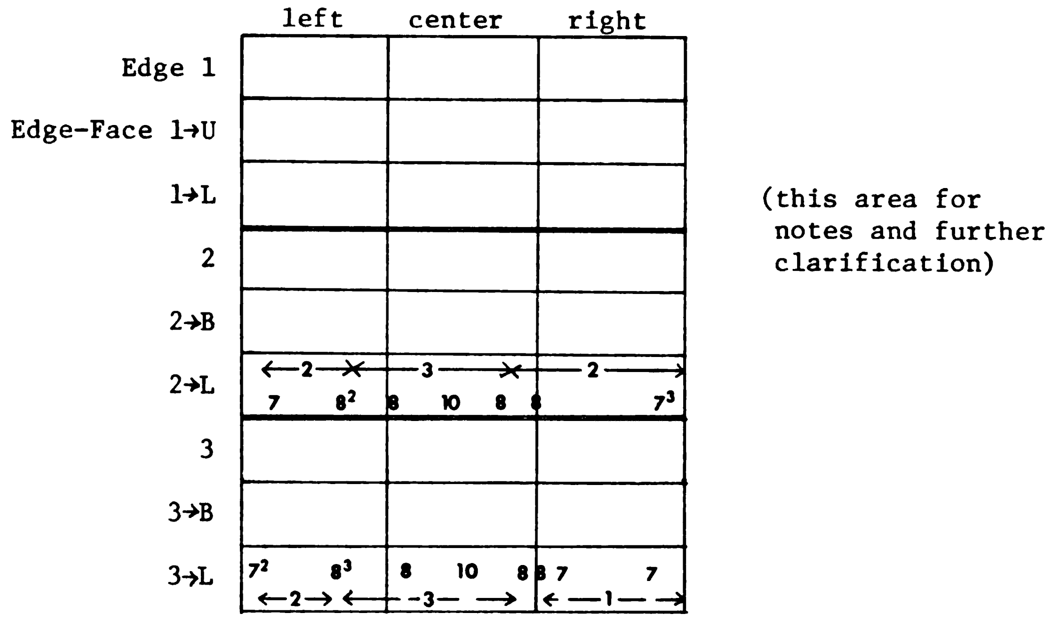


Figure 26: Data Recording Matrix

Data recording procedures. -- Each type of damage was given a code number and additional coded responses were included for absence of damage or absence of a well-defined edge. Examination proceeded from left to right always. Repetitive procedures were considered essential for accuracy and to prevent skipping areas. Superposition of types of damage was always preserved within the matrix, particularly when the damage pattern was complex. See for example, the edge-face locality 2→L in Figure 26 showing isolated small removals (codes 7, 8, 10) overlain by abrasion (codes 2, 3). This shows the examiner's perception that the abrasion overlies or is subsequent to the removals. It might just as easily have been the reverse as shown at locality 3→U.

Dividing each locality into thirds was purely a visual aid and could be at the discretion of the examiner. It would probably not be desirable to use too many subdivisions. If each item could have been held stationary during examination, a grid or some other device could have been used to refine accuracy (see discussion of microscope examination below), but this was not feasible.

Microscope examination. -- The microscope examination was carried out with a Baush and Lomb binocular instrument with zoom magnification from 10.5X to 45X. Use of low magnification has been criticized, specifically by Keeley (1974), largely because of the definitive pioneer work of Semenov (1964) which was accomplished by use of very high magnifications. However, this low magnification range proved not only adequate, but desirable in this context. Most of the abrasion and chippage observed and used in the subsequent analysis to demonstrate patterns of use would not have been clear at high magnifications because of the restricted surface area and very shallow depth of field visible. Semenov's methods and techniques are very carefully tailored to the narrow range of damage and use-effects that he hopes to see. Fortunately for those of us with smaller budgets, there is more than one road to heaven.

The most critical factors in observation of damage were lighting (both intensity and direction) and use of rigorously repetitive observation procedures. The light source was a variable intensity, mobile attachment to the microscope. Varying light intensity and direction proved to be the most effective and efficient method for revealing all types of damage and their minute characteristics. For this reason, and in order to facilitate the linear progression of examination along the edges, all items were hand held. Various coating techniques were tried and found unsatisfactory both because of the hand manipulation and because they simply were not as revealing as varying the light direction.

Typically, the examination of each small area involved variation of light intensity, light direction and degree of magnification through the complete range possible, each change revealing another aspect of the extent and character of damage to the surface of the piece since detachment from its core.

Classification of damage

Introduction. -- In addition to biases about tool morphology and functional localities, researchers also make a number of unconscious assumptions about the nature of the damage they expect to see. An artefact passes through several stages after being struck - manufacture, use and abuse -- and all of these may produce the same types of "damage." It is quite conceivable that a repetitive use to which a series of flakes is put could produce damage consistent enough in character to be regarded as retouch. Yet, it is frequently assumed that the difference between retouch and damage will be clear. In fact, the distinction is seldom clear (see also discussion p.104 ff.) expecially when the "damage" is very small or microscopic. Because the artefacts in this collection were themselves very small, all damage was small, including retouch. The small flake removals which give these items their blunted backs and characteristic shapes have always been regarded as retouch and quite likely this is true. However, examination of only a few items showed clearly that many other types of damage were also present at this locality. Since there was already more than adequate reason to be suspicious of traditional assumptions about function and functional localities, the inclusion of the so-called "retouch" in the damage analysis was inevitable. Ultimately, it became clear that no confident distinction could be made in advance about the intent of any particular modification to the original flake. Therefore, all modifications, major, minor and microscopic, were initially regarded as "damage."

Macro-damage: breakage. -- One type of damage had to be dealt with even before the microscope examination began. A large number of items had sustained damage in the form of breaks or snaps resulting in major reduction of the item. Breakage was examined in the course of the shape analysis for the entire sample because it was frequently necessary to distinguish between breaks which had been incorporated into the shape and breaks occurring after the final intended form had been achieved. As the previous discussion of backed blades has made clear, the distinction could not always be made with certainty. If what remained of an item after a snap conformed well with any of the shape categories, it was easy to regard the snap as a break (see Figure 27).

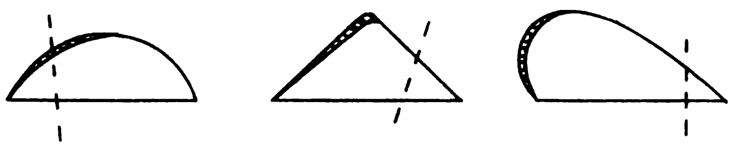


Figure 27: Typical Locations of Snaps

However, on items which do not approximate one of these categories, snaps have conventionally been regarded as intentional. There were a number of backed pieces with break scars which were not easily assignable to any conventionally recognized category. The items shown in Figure 28 below could be remnants of any of several different shapes.

Vertical snaps were classified by approximately how much of the original tool was present -- most, half, less than half, or indeterminate.

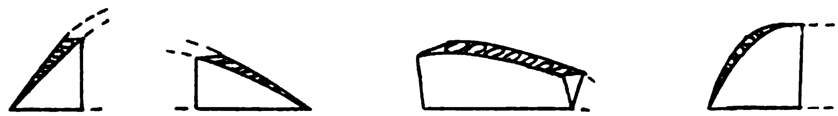


Figure 28: Typical Remnants of Breaks

The angles of the vertical breaks were recorded. With the item oriented properly, the angle was measured using the original lateral flake edge as the base line as shown in Figure 29.

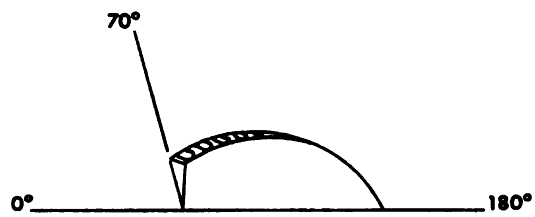


Figure 29: Measurement of the Angle of Snaps

Breaks whose angle to Edge #1 approached zero had to be major reductions of the sharp edge or back in order to be classed as breaks (see Figure 30).

Figure 30: Snaps Whose Angles Approach Zero

It is quite possible that breaks occurring in the back of the item were actually initial, intentional breaks of the raw flake to approximate the final shape which simply remained unmodified. If the line of the break did not diverge markedly from the line of the back, this was assumed to be the case. The implication of lengthy breaks along the sharp edge, however, was not clear. Some obviously resulted from weakness of the sharp edge, expecially because of fracture planes in the raw material.

Micro-damage. -- Micro-damage (attrition without major alteration of shape or size) was expected to include some or all of the following types. Expectations were based upon previous work and observations, the nature of the raw material and possible functions. Some of these were: abrasion (as distinguished from silica sheen by Witthoft (1967)); flaking; striations; and possibly even silica sheen itself, although, in the end, no damage conforming to the definition of silica sheen was observed. The list of types of damage was amended and refined with every new item examined until the danger of completely unique damage for every item dampened the enthusiasm for further refinement. The final list of possible descriptive responses follows:

Absence of damage
Abrasion (light, medium, heavy)
Nibbling
Snaps
Striations
Flakes (shallow, flat, without hinge, any shape)
Flakes (hinged or stepped)
Removals along fracture planes
Fracturing
Edge not clearly defined

Some of these types of damage are always restricted to edges without any invasion of the face (snaps, nicking, fracturing). Others occur only on faces leading away from edges (flakes, removals along fracture planes). Abrasion, of course, could be restricted to edges or faces or extend over both.

It should be clear from this list, that describing damage in this was is quite distinct from the more common convention of description with reference to gross pattern. Each descriptive response is a type of damage defined by its own characteristics rather than how it is manifested upon the tool. Phillipson and Phillipson (1970), for example, describe a "type" of damage they call "crushed and dulled points." But this is a pattern involving several types of damage, probably crushing, abrasion and flaking as well as a locality designation. Recording the damage as I have described did not make recognizing locations of intense attrition difficult. Perhaps the greatest advantage to structuring the description by types rather than patterns of wear is that recognition of patterns requires such a great deal of exposure to and familiarity with the items being considered. Repetitive examination and comparison would be necessary before one could begin to group items by the character of the patterns they displayed. Even then, the risk of perception overlap would be high. By contrast, describing types of damage may commence almost immediately with relatively little unproductive microscope time and without much repetition. The intuitive "feel" that one develops for pattern during the examination can then easily be checked against the record of damage types and their locations The contrast between these two perspectives on description will be dis cussed further as it applies to each type of damage.

The problem of unreliable evidence has not yet been discussed except to describe the history of this collection since excavation. On the basis of post-excavation handling alone, there is ample reason to expect that a good deal of the damage to these tools has nothing to do with aboriginal use or misuse. Because Edge #1 is a thin, original, lateral flake edge, it is of course the most suspect of all localities. Of all the types of damage observed to occur on this edge, only abrasion was regarded as relatively reliable in and of itself. The kinds of handling and packing and storing of tools in contact with other stone tools was regarded as probably productive of high intensity damage, namely nicks, snapps, flakes, or breaks. This supposition could obviously be easily tested with a sack of small flakes struck from the proper raw materials. There was, unfortunately, no opportunity to do this.

There were few physical clues to the relative antiquity of damage. Even where one type of damage was clearly subsequent to another -- a highly suspicious example being abrasion partly obliterated by chipping or flaking -- one could not be absolutely sure that the chipping was not ancient. Repetitiveness and association with other types of damage were considered to be the most reliable clues to the antiquity of wear.

Abrasion. -- Abrasion, neither silica sheen nor crushing, was nearly a constant characteristic of the sharp edge resulting in edge dulling and rounding. Thirty-three of the forty items examined showed abrasion along the entire length of the sharp edge. Two more were abraded along more than 80% of this edge. Only five items had less than 60% of this edge abraded and only one of these showed no abrasion at all. Abrasion was also a common characteristic of the blunted back. It frequently occurred restricted to the back/face intersection from which the blunting was directed, but often extended away from the edge along the ridges and prominances of the back and/or face.

Three categories of abrasion were imposed at the beginning. About midway through the sample, it became apparent that, although the three-level distinction might be meaningful, it was not practical. There was too much tendency to judge the intensity of abrasion only in terms of the item being examined or the previous item. Abrasion might be heavy at one end compared to the other end, but compared with the preceding item -- the preceding dozen items? It became impossible to remember as the examination stretched over many weeks. The problem stems from the fact that until an entire sample has been examined, it is impossible to know what the heaviest abrasion will be like. What looks like heavy abrasion today may look like medium tomorrow. Perhaps an initial scheme of light vs. heavy with a plus or minus added if extreme variation is encountered would provide a more comfortable mental template with which to commence. In any event, the most important distinction in the subsequent pattern analysis were the changes in intensity on the same tool.

As already mentioned, abrasion as I have defined it, includes abrasion restricted to edges as well as invasive abrasion. By contrast, Phillipson and Phillipson (1970) do not refer to abrasion specifically, but to the gross pattern produced by abrasion. They describe rounded or dulled edges and polished surfaces. But, both of these are manifestations of abrasion and no confusion resulted from describing both patterns in terms of the lower level attributes of the damage.

Although the sharp edges could all be characterized in a general way as rounded or dulled, this was far from a homogeneous or uniform phenomenon. For one thing, abrasion did vary in intensity both from item to item and upon the same item. Several other types of noninvasive damage were observed on this edge as well, also with variation in intensity, density and location.

Nibbling or nicks. -- This type of damage occurred exclusively on the thin, original flake edge (Edge #1). These were minute, non-directional removals occurring singly (nicks) or in series (nibbling).

Snaps. -- A snap is a somewhat larger, non-invasive removal from an edge. It had to be large enough so that the surface of the scar was readily apparent, possess no identifiable flake features and not significantly reduce item size or alter item shape.

Figure 31: Visualization of Snaps to Sharp Edge

Snaps could not be considered invasive damage, but frequently did indicate by the angle of their scars the direction of removing force. This face was considered in determining reliability by association (or lack of it) with other damage at specific locations.

Striations. -- Striations are minute scratches in the surface of the raw material. They can occur only on face localities and were usually associated with edges. They can only result when the tool comes into moving contact with a grain of material of the same hardness or harder than the item. Location, origin, direction and number of striations were always recorded. Unfortunately, they were infrequently observable at the magnifications used. This is perhaps one instance when the higher magnifications used by Semenov (1964) would have been helpful.

Flakes. -- A good deal of invasive edge attrition was in this category. This type of damage lends itself to almost infinite refinement of description and there are a number of different perspectives to take on description as well. Two common perspectives are: 1) to describe the flake damage by reference to the character of the entire damaged area; and 2) to describe the damage by reference to the morphology of individual flakes. Bordes' classification of retouch (1969) into scalar, stepped[1] scalar, parallel, and sub-parallel categories is an example of the first perspective. Phillipson and Phillipson (1970) also refer to flaking in terms of gross pattern displayed. They observed what they call "stepped damage" and "scaled damage." Stepped damage seems to be a pattern composed of flake removals having hinged distal ends. Scaled damage refers to a pattern composed of flake removals generally without hinges. Patterns of flake removals observed on the Rangi material included isolated removals as well as patterns composed of each type of flake, alone or mixed. Nance (1970) as well classifies damage flakes into four categories as if they were homogeneous, continuous phenomena -- in other words, by gross pattern rather than by lower level attributes.

In contrast, Hayden and Kamminga (1973) distinguish by cross-sectional profile seven different types of flakes: invasive,

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[1]It should be noted here that American writers use "hinged" and "stepped" interchangeably. Bordes' definition of "stepped" has only the connotation of overlapping, or ranked, rows of flakes.

invasive-break, four types of "stepped" flakes, and another stepped-break flake. Perhaps a third perspective is that taken by Frison (1968) who classifies retouch flakes by reason for removal.

Classification schemes for both retouch and damage were considered in the initial formation of expectations because both retouched and unretouched edges were going to be examined without assumptions about where utilization effects were most likely to occur. Because of the size of these artefacts, all flaking was relatvely small and the same scheme proved satisfactory for both retouch and damage. The Phillipsons (1970) note as well that no certain distinction can be made between use-damage and retouch-damage on the basis of microscopic features alone (their p. 41).

I finally made only two descriptive distinctions for flakes. The first was between flakes with hinges and those without. The second was a rough distinction made between average sized (0.5 to 1.0 millimeter on Edge #1) and very small flakes which often intergraded with nicking. It perhaps does not go without saying that only removals with recognizable flake characteristics were called flakes.

Minute invasive flakes, both hinged and flat, displayed two patterns on the sharp edge. They could occur either in aggregates or isolated. Hinged and flat flakes occurred separately and mixed together in both patterns. A word here might be valuable concerning the correlation of patterns of flake damage described by Phillipson and Phillipson (1970) to the patterns I observed. Plate 2b on page sixty-three of their report shows what they call step flaking (one of the two flaking patterns they describe). This is a good example of what I would describe as an aggregate of hinged flakes and edge fracturing. This correspondence seemed fairly straightforward. They also describe a pattern called "scaling" (shown in Plates 2e and 3b-g). This is much more difficult to correlate. Their various examples show that "scaling" can be composed of one type or a combination of several types of damage. Their photographs show aggregates of both hinged and flat flakes, together and separately as well as snaps, nicks, and nibbling. Also, some of the photos seem to indicate that they included isolated flakes within the definition of scaling (Plate 4efg, p. 67). In general, I regarded isolated flakes as of dubious reliability unless there were other clues to their antiquity. The Phillipsons apparently felt very confident about the antiquity of all damage they observed (their p. 41) even though the artefacts they studied were collected from the surface.

The patterns of flaking (but not the types of flaking) observed on the blunted back differed in character from those on the sharp edge. They occurred most frequently in aggregates, were more regular and sometimes parallel, and were frequently contiguous rather than overlapping. As on the sharp edge, flakes leading away from Edge #2 and Edge #3 (onto the back or the faces) could be hinged or unhinged, homogeneous or heterogeneous. The more regular character lends credence to their interpretation as intentional retouch, but they were associated with other types of damage, especially abrasion and fracturing, which were not so easily interpreted.

Removals along fracture planes. -- Removals along fracture planes could be invasive or not. In either case, they were not considered reliably ancient unless associated with other, more reliable, damage. By far the bulk of the raw material was, in fact, riddled with impurities and zones of weakness and isolated removals of this type were common.

The necessity of this category was unanticipated prior to the examination. These invasive removals result from the poor quality of the raw material used for these tools, however, it seemed likely that they could have occurred during utilization. They had no typical size or shape, though they were generally larger than flakes and they never possessed flake characteristics.

Fracturing. -- This type of damage was extremely distinctive and, like fracture plane removals, was not anticipated. Though it typically involved some crushing, it was quite clearly distinct from crushing. It occurred primarily along Edge #2 and #3. It took the form of minute, shallow fractures extending into the raw material at the angle indicated in Figure 32.

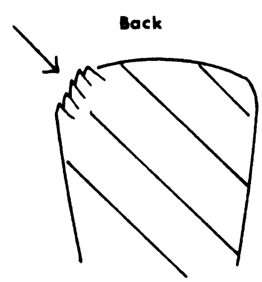


Figure 32: Visualization of Fracturing

Undamaged edges. -- The list of descriptive responses also included codes for absence of damage as well as absence of a well-defined edge. It frequently happened that portions of one of the edge/back intersections did not interset sharply, but simply rounded into each other. This was due sometimes to removal of the intersection by the distal ends of small retouch flakes struck from the other face, sometimes to the poor quality of the raw material.

Results of the study of macrodamage

Of the entire sample of 233 backed items, 25.8% (60 items) showed scars of vertical snaps or breaks. Of these "broken" pieces, 18.3% (11 items) were points, that is, the backing intersected the lateral flake edge on what was left of the tool (see Figure 28, p. 90). It is simply impossible to say that these pieces are remnants of some particular geometric form, although they would conventionally be classed as broken crescents. They could be broken crescents, J-shaped items or the tips of curved backed forms.

Rectangular pieces with one or two vertical snap scars accounted for 23.3% (14 items) of the broken pieces. It is not readily apparent how much of the original item these pieces represent. These are conventionally classed as backed blades and regarded as whole tools. The shapes intergrade with trapezoids perfectly, the difference being that trapezoids are usually defined as having retouch on two or three sides.

Of the items with vertical breaks, 58.3% (35 items) actually have only minor damage to either tip with enough of the tool remaining to permit classification. Four of the remnant, unclassifiable points (36.4%) also had broken tips, but no two-pointed item had more than one broken tip. There was no difference in the tendency of one- and two-pointed items to have broken tips. On 32 broken tips for which the angle formed by the back and the sharp edge could be approximated, 90.6% were 45^{o} or less. Because of the excessive handling this collection received prior to examination, the implication of damage to points this fragile must be doubtful.

The average angle of the major break on the mostly unidentifiable remnant points was 84.5^{o} and for the rectangular pieces, 86.4^{o}.

However, the angle was 90^{o} on all except one of the points and on the rectangular pieces, only two diverged from 90^{o} by more than 8^{o}.

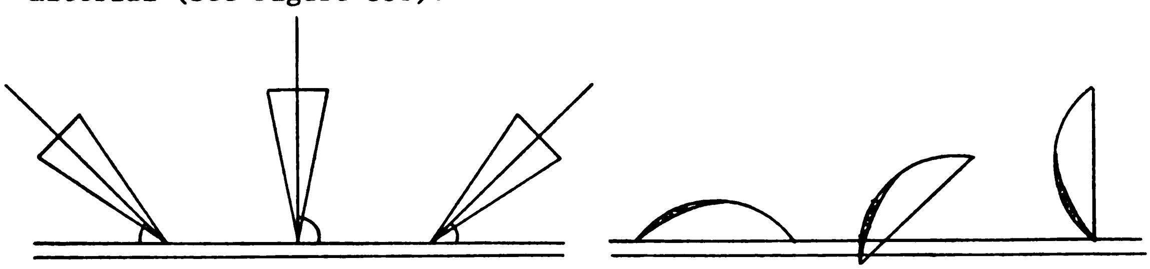
It would be tempting to assume a relationship between the rectangular pieces and the points. The angles of the break scars are similar and the tests on dimensions (p. 64 above) showed a high probability that "backed blades" with snap scars are not the same as those without -- that is, they are either broken tools or different tools. However, the average difference between broken and unbroken "backed blades" is 3.6 millimeters. The average length of the remnant points is 11.6 millimeters (s = 2.1 millimeters). If these pieces were related, their average length would be around 27 millimeters, which is within the range of unbroken straight and curved backed pieces, but beyond +1 standard deviation from the mean. Of course, it is possible that longer items were more susceptable to breakage. It is also a factor that a piece 3.6 millimeters long, even allowing for variation, would in incredibly difficult to recover.

There was no difference in the tendency of each of the four different raw materials to sustain major and minor breakage. There was however a higher percentage of chert and quartz and obsidian in the sample of broken items than in the total sample. The probability that this difference in distribution was accidental was low (P = 0.3 to 0.2), but not statistically significant. This difference in raw material among broken items from the over-all distribution was paralleled, but more extreme when one-pointed and two-pointed items were examined. The raw material distributions for both two-pointed items and one-pointed items were different from the over-all distribution and markedly different from each other. Both classes showed similar percentages of vein quartz and quartz and quartz crystal, similar both to each other and to the overall distribution. However, two-pointed items displayed a lower than expected selection of chert and a higher than expected selection of obsidian, while one-pointed items showed the reverse. Both distributions showed a low, but non-significant, probability that there was no difference from the overall distribution (P = 0.2 to 0.1), but an extremely low probability of no difference (P = 0.01 to 0.001) when compared to each other. It would seem that although there was a low preference or availability of cryptocrystalline quartz, it was selected to some extent for the manufacture of one-pointed items. The slightly higher tendency for chert items to be broken may be a reflection of its own properties or of the uses to which one-pointed tools were put.

Micro-damage to the sharp tool edge

The sharp edges of these tools suffered both invasive and non-invasive attrition. Type (invasive or non-invasive), location, and density of damage was used to reconstruct patterns -- that is, angles and directions -- of use.

Several kinematic factors were explored, namely, the angle formed by the plane of the tool with the plane of the raw material (see Figure 33a) as well as the angle of the length axis with the plane of the raw material (see Figure 33b).



a. b.

Figure 33: Visualization of Working Angles

Additional factors included whether the tool was drawn or pushed in one direction or two and whether this was done perpendicular or parallel to the length axis. An aspect of wear that Phillipson and Phillipson (1970) do not consider in depth is location, except that they list "crushed and dulled points" as a pattern. However, the manner of use has clear implications for the location of damage and thus location is a very important factor in reconstruction of use patterns. When all items in the sample had been classified by apparent use-motion, then the minor variation in type and intensity of damage was examined more closely for pattern.

As a preliminary step to pattern discrimination, the tools were subdivided by the character of non-invasive attrition along the sharp edge. Three patterns, based upon type and intensity of wear, seemed distinct. The simplest pattern (Pattern #1) was uniform intensity abrasion along the entire length of the sharp edge, uninterrupted or modified by other non-invasive damage such as snaps, nicks, nibbling or fracturing. The other two patterns both involved damage which varied in intensity along the edge. The first (Pattern #2) is simply abrasion with points or patches of heavier abrasion. The second (Pattern #3) is abrasion combined with spots or areas of higher intensity damage -- namely, nicks, nibbling, snall snaps, or even fracturing.

There were eight items showing Pattern #1 (uniform intensity abrasion), ten showing Pattern #2 (mixed intensity abrasion) and twenty-one showing Pattern #3 (abrasion combined with nicks, nibbling, or snaps). The significance of the character of non-invasive wear to invasive wear and to kinetic patterns was discovered much later (see p. 113 ff.).

As mentioned, use patterns were reconstructed on the basis of type, density and location of damage. Unfortunately, not all investigators have paid much attention to these aspects of utilization and those who have do not all agree on the relationships between these phenomena and the act that produces them. Semenov (1964, p. 109) believes that an edge used in a whittling motion produces no damage to the dorsal face. However, Keller's (1966) experiments show evidence contrary to this assertion. His experiments, with the blade edge at a very low angle to the raw material produced bifacial wear. But Keller's experiments are far from conclusive or even directly comparable to Semenov's observations. For one thing, Keller used obsidian which is very brittle. For another, Keller himself notes that several of his experiments were very inefficient, that is, the motion rendered the flake dull and unserviceable very quickly. Keller uses this fact to point out that type frequencies in a collection do not necessarily reflect the amount of time spent using the particular tools. He says (his p. 510) that some tools can be used much longer than others and so "equal percentages of cutting and scraping tools would probably represent more scraping than cutting" because cutting tools don't last as long. However, the efficiency rating of his experiments might just as logically indicate that he failed to hit upon the most efficient method for accomplishing the task and/or using the tool, or, simply, that obsidian wears differently than other raw materials. One of his whittling or paring motion experiments was "efficient" and it did produce primarily dorsal face damage. Two other "scraping" experiments, in which the flake was held as a relatively large angle to the raw material, were also efficient and also produced dorsal damage. Another clue to the resolution of the different results reported by Semenov and Keller is the character of the damage they describe. Semenov is most attentive to and concerned with the traces of abrasion and striations while Keller ignores these almost entirely and reports primarily the occurance of flake removals. Semenov refers to flake removals as "retouch" (his p. 20) rather than damage and mentions them only briefly. Figure 34 shows that it is quite logical that the two types of damage would be produced on opposite faces.

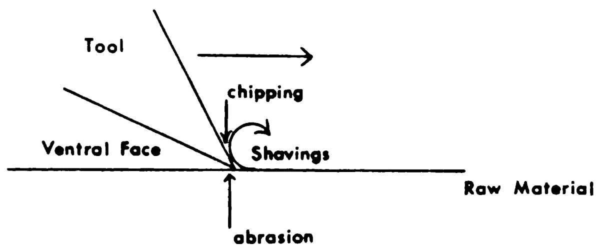


Figure 34: Locations of Damage Produced by Whittling

The ventral face of the tool picks up polish and striations as it slides across the raw material. The distance this abrasion extends from the edge would depend upon the angle of the flake to the raw material. Whittling of both bone and wood tends to produce thin shavings which curl up from the surface across the dorsal face. Semenov notes that these shavings do not produce much wear because they tend to curl away quickly (his p. 20). But the downward pressure of the tool against the raw material and the curling away of shavings should be more than enough pressure to account for flake removals from the dorsal face. Semenov, as mentioned, interprets these flake removals as "retouch." Many of his illustrations of "meat knives" and "whittling knives" show this dorsal "retouch" (see his p. 103, 106, 108 and 112).

Phillipson and Phillipson (1970) report that their replicative experiments with microliths produced invasive attrition ("scaling" and "step flaking") on the "non-leading face" of the tool (their p. 43). For the life of me, I could not decide what this meant tnd the rest of their discussion did not really clarify the issue, but I decided to assume they meant the face not in contact with the raw material. Happily, this assumption makes their results consistent with my interpretation of Keller and Semenov. One of their experiments however could have produced invasive damage differently. Their "scraping" experiments involve dragging the edge of the tool across the raw material at an angle of 90^{o}, higher than the angle used by Keller (see Figure 35).

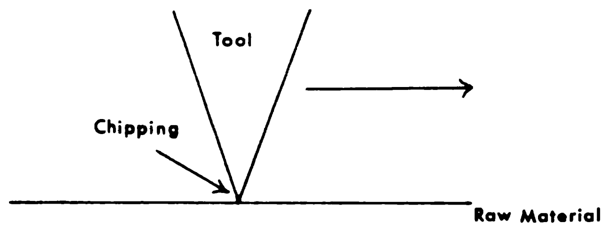


Figure 35: Scraping Experiment of Phillipson and Phillipson (1970)

I would expect this motion to remove flakes from the ventral face due to the angle and direction of the pressure on the edge. However, this aberrant pattern was not considered troublesome because the Phillipsons report that the efficiency of this motion was extremely low, almost to the point of total ineffectiveness (their p. 45). This is not at all a surprising result considering the thinness of these edges and the tremendous pressure produced by this motion.

The Phillipsons report that bifacial damage occurred only if the piece were either turned over and used again or used at a 90^{o} angle to the worked material as a chopper or drill, or perhaps scraped back and forth. This model for production of invasive attrition, together with distribution along the sharp edge, allowed inference of both use-angles shown in Figure 33, p. 102.

For purposes of analysis, use angles were defined in terms of the orientation adopted for microscope examination (see p. 82). If this orientation is maintained, each use angle has three possible gross variations as shown in Figure 36. There are nine possible com-

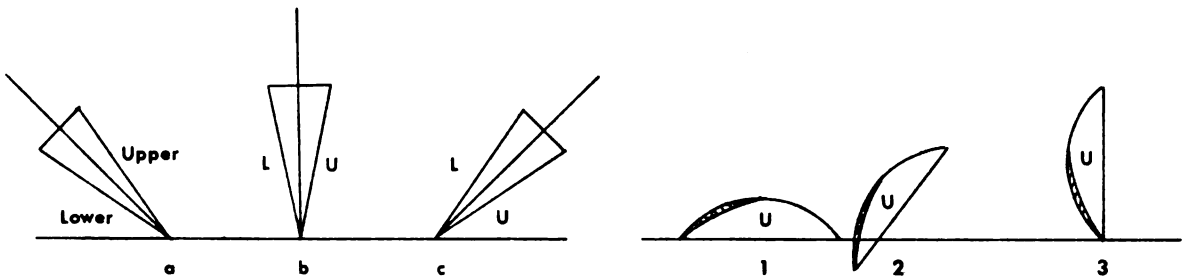


Figure 36: Coding of Use-Angles

binations of these gross variations. The concept of these angles and their relationship may easily be grasped with the aid of a matchbook or a small protractor (or see MacCalman and Grobbelaar 1965, Plate 15). Location of wear is the primary evidence. For example, if invasive damage is concentrated on the upper face of the left end of a tool, angle 2a is automatically indicated. This turns out to be a rather natural right-hand position suitable for drawing the tool toward the user. Absence of invasive damage combined with minimal dulling of the sharp edge might indivate minimal use. This pattern did in fact occur, but only on one tool. The lack of invasive damage leading to a 1b description of use angles almost invariably also involved sufficiently heavy dulling of the sharp edge to indicate a reasonable amount of use.

Because of the artificial imposition of a standard orientation, the nine combinations of tool angle are not mutually exclusive. With no regard for standard orientation there are only five mutually exclusive combinations. All of the combinations are shown below with those which are mutually exclusive marked with an asterisk. The imposition of the

*1a
*1b
1c (reciprocal of 1a)
*2a
*2b
*2c
3a (reciprocal of 2c)
3b (reciprocal of 2b)
3c (reciprocal of 2a)

standard orientation was necessary in order to cope with tools which had actually been used reciprocally and to examine the aspects of morphology dictating the location of damage.

Of the five mutually exclusive angle combinations, one (2b/3b) was not observed in the sample. The most common tool orientation was the 1a or 1c position. These tools showed non-invasive damage along the entire sharp edge combined with invasive damage evenly distributed along the edge on one or both faces. Seventeen tools showed this pattern of use, apparently either pushed away from or drawn toward the holder. Six of the seventeen tools were used reciprocally, that is, turned over and perhaps used in a different direction. Five tools (none used reciprocally) showed by minor differences in intensity along the sharp edge that they may have been used at a very slight angle to the worked material. It appeared that although the entire edge was in contact with the worked material, there may have been slightly more pressure at one end than the other.

Because many tools showed extra damage to one or both points, it occurred to me that an alternative explanation for the even distribution of invasive damage along the edge on one face might be reciprocal use at an angle to the worked material, that is, using both ends of the tool at an angle. However, the logistics of this are not compelling. If the tool is held in the 2c position (a natural right-hand grip suitable for pushing or drawing the tool away from the user), invasive damage should be produced from the center to the tip on the lower face. If the tool is simply turned over and used in the same manner, damage is produced from the center to the other tip <u>but on the upper face</u>. Two tools did in fact show this type of reciprocal use. However, to produce damage to the other half of the tool on the same face, the worker would either have had to change hands and use the same motion or else pull the tool toward himself with the same hand <u>after</u> turning it over.

Thirteen tools showed non-invasive damage to the sharp edge not combined with invasive damage indicating the 1b position or perhaps reciprocal use in the 2b and 3b positions. This sort of reciprocal use is not unreasonable in the same sense as the previous example. However, it seems likely that if reciprocal use were the cause of this pattern, there would have been some tools showing only the 2b or 3b position and there were none.

Nine tools showed strong evidence that they had been used with the sharp edge at an angle to the worked material (use-angle 2 or 3). Five tools showed evidence of the 3a/2c pattern. Two of these showed both use patterns indicating reciprocal use. Three tools showed the

2a/3c pattern, and another, 3a and c, that is, bifacial damage from the center to one end. The 3a/2c pattern turns out also to be a natural right-hand position (thumb up or down, see Semenov 1964, p. 108) for pushing or pulling the tool away from the worker in a kind of whittling motion. This motion was reported by the Phillipsons (1970) to be very effective for working wood. Although only five tools showed this pattern clearly, another, classed as 1c, was a possible candidate for this pattern too, having invasive damage slightly, if not exclusively, concentrated near the left end on the lower face. Four tools, classed as 1a, also showed minor variations in the distribution of intensity suggesting (if not demonstrating) a near 2a use pattern. One tool in the sample was not classified by use pattern. Its sharp edge was so broken, no pattern could be inferred.

TABLE 25

FREQUENCY OF USE-ANGLE COMBINATIONS

Use-Angle	f	Total
1a	6	
1c	5	
1a & 1c	6	
		17
1b	13	
		13
2a	1	
3c	2	
		3
2c	3	
3a & 2c	2	
		5
3a & 3c	1	
		1
?	1	
		1
		40

None of the thirteen items classed 1b showed any significant invasive damage. Obviously, the use of the word "significant" implies a judgment. All of the tools showed a few isolated flakes. On eight tools, these were isolated, randomly distributed and bifacial. On one of these eight, all of the isolated flakes were unhinged. On the other seven, they were a mixture of hinged and unhinged flakes. Four tools showed rare, isolated flakes on the upper face only. One of these had unhinged flakes only, two hinged flakes only, and one had both. On the last item, the invasive damage, consisting of a few isolated flakes, looked very fresh. This sort of damage was judged insignificant because its random, low intensity character did not suggest or relate to any pattern and could easily be attributed to factors other than utilization. The additional fact that all but one of these tools showed fairly high intensity non-invasive wear made the rarity of invasive damage more significant than its meager presence. There was a slight tendency for these isolated flakes to be all of the same type on any given face, that is, either all hinged or all unhinged. On the twelve tools showing these rare random flakes, eight of the twenty-four faces showed only unhinged flakes and six showed only hinged flakes. Two tools showed heterogeneous flaking on both faces and three tools showed homogeneous unifacial flaking. There was a slight tendency for the tools showing homogeneous flaking to have hinged flakes on one face and unhinged flakes on the other (about 2/3 each type were opposed to the other type).

All but two of the 1b items showed non-invasive wear Pattern 3 consisting of abrasion combined with nicks, nibbling, and/or snaps, but with no apparent variation in distribution along the edge. The association of this non-invasive wear pattern was marked in a statistical sense. When a chi-square test was performed on the distribution of non-invasive edge wear patterns to manner of use patterns, the probability of accidental association was low (P = 0.3 to 0.2) with the strong association of wear Pattern #3 with use pattern 1b and wear Pattern #2 with use pattern 2a/3c (3a/2c) accounting for most of the high chi-square value (see Table 26).

Phillipson and Phillipson (1970) attribute lack of invasive damage to a sawing motion (their p. 46), but their experiments produced only dulling of the sharp edge, not nicks and snaps. Keller also reports production of this pattern with a sawing motion, but he produced a similar pattern by employing a paring motion on soft wood. This use on soft wood (not employed by the Phillipsons) did result in an increased frequency of snaps to the sharp edge.

None of the tools showing the 1b use pattern showed any extra or significant wear to or near points even though most of them had serviceable points.

The attribution of a use angle 2 or 3 depended primarily upon a concentration of non-invasive and/or invasive damage near one end of the sharp edge. The amount of damage had to be dense enough not to be accidental. The attribution of a use angle combination meant not only a concentration of damage indicating those angles, but an absence of damage suggesting any others.

Among the nine items classed as having been used with the sharp edge at a definite angle to the raw material, five showed dense (contiguous) concentrations of flat, unhinged flakes on one face near one end. Two of these five tools were used reciprocally, that is turned end-for-end and used in the same manner. The reciprocal uses produced the same pattern, making a total of seven uses producing this pattern of invasive damage. Three other tools showed numerous, but not contiguous, flat, unhinged flakes on one face near one end. One tool showed a dense concentration of mixed hinged and unhinged flakes. Thus, on nine tools showing eleven uses, ten of these uses produced the same type of invasive damage. This high tendency of tools used at angles to the raw material to show homogeneous damage may indicate a more homogeneous function than for those classed 1a or 1c.

As mentioned, there was a correlation of non-invasive damage Pattern #2 (mixed intensity abrasion) with the 2a/3c use pattern. Although invasive damage clearly suggested by its location use at an angle to the worked material, non-invasive damage was apparent along the entire edge. However, on seven of the nine tools, the non-invasive damage showed clearly increasing intensity consistent with the location of invasive damage. Two of the tools showed simple abrasion, with no changes in intensity along the edge. One of these was classed in the 2c use pattern, but the distribution of damage did show that the angle of the sharp edge to the material worked, though definite, was probably low. That is, invasive damage was present along 2/3 to 3/4 of the lower face, the right end being free of damage. The other item showing evenly distributed abrasion had been used reciprocally (3c and 2a). Thus the variation in non-invasive damage within this class was entirely due to progressive increases in intensity in one direction along the edge. This was true of non-invasive wear Pattern #3 as well as Pattern #2. This is contrary to the character of wear Patten #3 within use pattern 1b. In that class, variation in intensity did not show direction.

Seven of the items in the 2a/3c class showed higher intensity damage to points. Three points (one each on three tools) showed abrasion resulting in a rounded, reduced point. Two of these were completely consistent with the distribution of other damage, but one was not. This aberrant tool, however, did not have actual points. The backing curved under on both ends giving the piece a circular appearance. It had sustained bifacial invasive damage to the right half (3b) and very localized, heavy abrasion to the left end. One tool had sustained a small break or snap to one end, which was unrelated to other damage and three tools showed major breaks only one of which seemed related to other wear. Thus, of the seven cases of point damage, only three seemed to be related to other wear. However, one of these, the item with the small snap, is clearly open to an interpretation of accidental or recent damage. Nevertheless, the presence of point damage was marked in this use pattern class (see Table 26) and association with other wear, especially abraded points, seemed higher than shown in the 1a/1c class.

The attribution of use angle 1a or 1c depended upon the density and distribution of invasive damage to either one or both faces. If invasive attrition consisted of flakes which were not contiguous along the edge, they had to be numerous (5-6) or large. A 1a and/or 1c classification depended upon the continuous or, at least, even distribution along the edge. Twenty-three out of thirty-four faces (seventeen tools = thirty-four faces) showed this pattern of invasive damage. Nine faces showed continuous overlapping attrition along the entire edge. Thirteen showed numerous, but isolated removals. One face had invasive damage to about half the edge, but concentrated in the center. There was a slight tendency for attrition to be homogeneous (fourteen of the twenty-three faces (61%)). Eleven of these showed only unhinged flakes and three only hinged flakes. The remaining eight faces showed mixed hinged and unhinged flakes. On the six tools with bifacial damage, all but one showed the same type of attrition on both faces.

Eleven tools from this group (1a/1c) showed damage to points that was higher intensity or different than other edge damage. Six points (on five tools) showed abrasion and/or flaking resulting in a rounded or crushed appearance. Only one of the rounded points seemed to be related to other damage on the sharp edge. On two other tools, one point had sustained a small break or snap. One of these possessed other damage somewhat oriented to the point damage. Three tools had major breaks. One of these showed other damage oriented to the break. The lack of association of the edge damage with the point damage as well as the different use angle combinations necessary to produce damage along the entire edge as well as to points indicates either a multiple function tool or, more likely, a multiple motion task for some of these tools. The presence of serviceable points does not seem to be related to damage or use patterns. A chi-square test on the distribution of zero-, one- and two-pointed items according to patterns of non-invasive damage resulted in a high probability of accidental association (P = 0.7 to 0.5) as shown in Table 26. When number of points was compared to inferred use angles, the probability of accidental association was very high (P = 0.99 to 0.98). However, when use pattern (inferred from invasive damage) was compared to types of non-invasive damage, the probability of accidental association was low (P = 0.3 to 0.2) and when incidence of damage to points was correlated with use patterns, the probability of accidental association was very low indeed (P = 0.01 to 0.001). Absence of damage to points was very marked among items classed in the 1b use pattern class and presence of damage was almost as marked on items classed in the 2a/3c (3a/2c) use pattern class. The correlation of damage to points with use pattern was intensified if those five items classed as 1a and 1c were listed by the 2a and 2c patterns they faintly suggested. When point damage variation was broken down and compared to use angle pattern, the strong correlation was preserved. Again, use angle pattern 1b was characterized by the absence of damage to points. Use angle pattern 2a/3c (3a/2c) was characterized by a higher than expected number of broken items and a lower than expected number of items with undamaged points.

TABLE 26

CORRELATION OF USE ANGLES WITH OTHER ASPECTS OF DAMAGE AND MORPHOLOGY

		Patterns Non-Invasive Damage			
		1	2	3	T
Number of Points	0	1	1	2	4
	1	3	2	11	16
	2	4	7	8	19
	T	8	10	21	39

P of H_0 = 0.7 to 0.5

		Inferred Use Angles			
		1a[1]	1b	2a[2]	T
Damage to Points	Rounded	5	0*	3	8
	Broken	5	1*	4**	10
	None	7	12**	2*	21
	T	17	13	9	39

P of H_0 = 0.02 to 0.01

		Inferred Use Angles			
		1a[1]	1b	2a[2]	T
Patterns of Non-Invasive Damage	1	4	2	2	8
	2	5	1*	4**	10
	3	8	10**	3	21
	T	17	13	9	39

P of H_0 = 0.3 to 0.2

		Inferred Use Angles			
		1a[1]	1b	2a[2]	T
Number of Points	0	2	1	1	4
	1	7	6	3	16
	2	8	6	5	19
	T	17	13	9	39

P of H_0 = 0.99 to 0.98

		Inferred Use Angles			
		1a[1]	1b	2a[2]	T
Damage to Points	Yes	10	1*	7**	18
	No	7	12**	2*	21
	T	17	13	9	39

P of H_0 = 0.01 to 0.001

[1] 1a and 1c combined

[2] 2a, 2c, 3a and 3c combined

*lower than expected

**higher than expected

Microdamage and characteristics of blunted back

There were 229 artefacts for which at least some information was recorded about the character of the blunted back. Of these, forty were examined in detail in the course of the microscope examination. Blunting was a result, at least in part, of the removal of small, contiguous flakes on all of the 229 items.

On 151 items (65.9%), the back was formed entirely by small flake removals. On seventy-eight (34.1%) items, the shape was only partially a result of these flake removals. Where they were not flaked, these seventy-eight items showed a variety of other characteristics. Forty-one (52.6%) were further blunted by small snaps rather than flakes. Eleven (14.1%) showed traces of cortex incorporated into the back. Eighteen (23.1%) preserved a portion of lateral flake edge. Fifteen (19.2%) had the striking platform or bulb of percussion incorporated into the back. Eleven tools showed combinations of these characteristics. The most frequent combination (five tools) was presence of both the striking platform and a portion of the other lateral flake edge.

Conventional shape categories did not differ markedly in the frequency of continuous versus discontinuous flaking to achieve shape. Of course, most of these categories had too few items to make statistically valid comparisons. Only two categories of any size showed interesting deviations from the population percentages. Sixteen out of the seventeen straight backed pieces (94.1%) were blunted entirely by flaking. Trapezoids showed the reverse tendency. Only eight out of eighteen (44.4%) were formed entirely by flaking, the rest only partially.

As noted, additional blunting by means of small snaps was the most common characteristic of the back after flakes. However, there was no apparent tendency for any shape category to display these snaps more frequently than any other. The tendency to preserve portions of lateral flake edge was divided almost equally between so-called symmetrical crescents and curved back blades. Striking platforms were incorporated into the backs of seven crescents, but the other eleven occurances of this characteristic were distributed randomly among the other shape categories.

There was an expectable correlation between extent of flaking and raw material. Vein quartz, opaque to barely translucent and frequently containing impurities and irregularities, showed a significantly lower than average proportion of tools that were blunted entirely by flaking. By contrast, there were very few items of flint or chert which were not flaked along the entire back. The probability os this correlation being accidental, determined by a chi-square test, was very low (P = 0.01 to 0.001). This would seem to be a simple result of the difficulty of working the vein quartz. Why, in light of this, vein quartz dominates the list of selected raw materials in frequency is likely due to its availability or perhaps the superior quality of the sharp edge obtainable.

The standard orientation used when examining all tools functioned to make the flatter, ventral flake face the "lower" face of the tool. There was a strong association of flaking direction with the lower face. Only thirteen tools (5.7%) showed flaking directed entirely from the upper face. Flaking was directed solely from the lower face on 135 tools (59.0%). Eighty-one tools (35.4%) showed flaking directed from both faces (but see discussion of bifacial flaking below).

Phillipson and Phillipson (1970) note a difference in tendency for "crescents" and "backed blades" to show bifacial blunting

(42% vs. 14% respectively). The tendency in this collection was similar but not nearly so marked (see Table 27).

TABLE 27

DIRECTION OF FLAKING ON BACK

	Crescents		Backed Blades	
	f	%	f	%
Flaking directed from upper face only:	7	5.2	6	7.0
Flaking directed from lower face only:	77	56.6	57	66.3
Flaking directed from both faces:	52	38.2	23	26.7
Total:	136	100.0	86	100.0

The Phillipsons also note a strong association of bifacial flaking with longer, thicker items which was not seen here. The average length of bifacially flaked items was identical to that for the entire sample and the average thickness was somewhat less. These associations <u>were</u> linked here, but weakly. This study showed, as did the Phillipsons' (their p. 49), that "crescents" <u>tended</u> to be thicker than one-pointed backed blades and other similar forms and also that there was a slight tendency for a higher proportion of crescents to be bifacially flaked, but as noted, the tendencies were far from marked here.

The problem of correspondence with the work of the Phillipsons may lie partially with the difficulty of defining mutually exclusive shape categories that will suit one collection or one collector's perception as well as another and the largely subjective process of assigning items to these categories. The difficulty is particularly acute when the collection is large. The macrocategory which I called "crescents" seeme roughly equivalent to the Phillipsons'. However, in backed blades, I included items which do not precisely fit the Phillipsons' definition which was specific to their collection. For example, I included one-pointed items with one rounded end formed by flaking rather than by retention of the striking platform. Although this form apparently did not occur in their sample, it seems indistinguishable except for the characteristic noted. Another difficulty may lie with the definition of bifacial flaking. Many items in this collection showing flaking directed from both faces had an alternating rather than directly opposed pattern of flake removals. There was one other possible source of error in the data on bifacial flaking. Microscopic examination revealed a tendency to err in the perception of direction of flaking on the basis of eye examination alone. Only 72.5% of the forty items examined under the microscope had been described accurately by eye. The error was greatest with items of vein quartz and may be generally attributed to a preponderance of poor quality material and material with unfortunate refractive and reflective properties.

Identification by eye of bifacial flaking in the loose sense (not directly opposed) was 64.7% correct; unifacial flaking 77.3% correct. Five of the six bifacially flaked items incorrectly identified as unifacially flaked actually displayed only a small amount of opposed flaking. All of those unifacially flaked items which were incorrectly identified as bifacially flaked showed heavy abrasion or fracturing on the edge opposite the flaked edge. There was such a high association of fracturing or abrasion with flaking (see discussion below) that presence of fracturing apparently triggered an assumption of flaking direction. In addition, eye determination of flake characteristics (negative bulb, etc.) in this size range was very difficult and presence of fracturing at both proximal and distal ends compounded this difficulty.

The Phillipsons do not say how flaking directions were determined, but they report that their collection was composed almost entirely of high quality quartz crystal, so their figures may perhaps be regarded with more confidence.

Of those items subjected to microscopic examination, ten (25.0%) showed flake removals on the back in direct opposition. The amount of bifacial flaking (in this strict sense) ranged from a few flakes opposite the primary flaked edge to about two-thirds of the back showing flaking directed continuously from both faces. The average proportion of the back having directly opposed flaking was 43.0% (standard deviation = 15%).

Another seven tools showed flaking alternating from the upper and lower faces. The most common pattern showed one-third to one-half of the edge being flaked before the piece was turned over and finished from the other side. There was a strong impression that direction of flaking depended on the flatness of the face and the changing or consistent suitability as a striking platform (more probably, a pressure platform). One tool showed several changes in direction of flaking as if it had been turned over several times.

The most common pattern of flake types was a heterogeneous mixture of hinged and flat flakes in series from one or both edges. Twenty-two tools were backed primarily by these aggregates of heterogeneous flakes. Ten tools had aggregates of homogeneous unhinged flakes. One tool had both these patterns directly opposed continuously along the entire gack. The item was not particularly thick and the extra effort at flake removal is not readily explainable. Only three tools were blunted primarily by aggregates of hinged flakes alone, but four more had these in addition to a dominant pattern. Three were blunted half by a series of hinged, half by a series of unhinged flakes.

As mentioned, flaking was associated strongly with fracturing and/or abrasion at the edge of flake removal. Only five tools showed flaking not accompanied by abrasion and/or fracturing and on three of these, the "clean" flaking amounted to only a spot or small patch. The other two items (both chert) showed one-half and two-thirds of the back cleanly flaked. The most common pattern (twenty-three tools) was abrasion overlying fracturing at proximal flake ends. Four more tools showed flaking with mixed fracturing and abrasion, five showed flaking with fracturing only and five with abrasion only.

The microscope examination supported the imporession gained from the eye examination that edge fracturing (considered separately from abrasion) was strongly associated with flaking. Only seven of the forty tools in the sample were completely free of fracturing at the proximal flake ends. Fourteen tools showed continuous fracturing at proximal flake ends and nineteen tools showed about 20 to 60% of the flaking free of fracturing.

L. S. B. Leakey's experiments (1931) with microlith fabrication suggest an explanation for this association. He found that by using another flake to press off backing flakes, he was able to reproduce two different tool types common to microlithic assemblages, namely, backed microliths and "lames ecaillees." These lames ecailees are commonly thought to serve as "chisels," but Leakey concluded from his experiments that they were fabricators. He does not discuss the microscopic character of the retouch produced by this method, but the experiments and effects should be relatively easy to duplicate by anyone reasonably skilled in stone working using a variety of raw materials for both the products and the fabricators. Leakey also found that this manufacturing technique was quite efficient -- much more so in fact than any percussion technique.

Although stone on stone pressure retouch technique could account for this kind of damage, certain tool uses could account for it as well. Arctic burins display the same type of fracturing to their working edges (Maxwell 1973). However, several factors seem to weigh against this being a use-produced damage. The regular character of the flaking has the appearance of retouch rather than damage from use and the flakes tend to be parallel and of even length and depth. Fracturing is strongly associated with proximal flake ends. Only five tools showed instances of edge fracturing not directly associated with flake removals. Two of these showed only isolated spots of fracturing; two showed very restricted patches (one-fourth to one-third); and one was fractured along most of the edge with only two or three accompanying flakes.

Abrasion was also strongly associated withflaking. Only six tools have flaking completely free of abrasion while twenty-three show <u>all</u> flaking accompanied by abrasion. Eleven tools have flaking partially ($\bar{x}$ = 42%) free of abrasion. However, abrasion was more likely than fracturing to occur <u>not</u> in association with flaking. Twelve tools showed edge areas abraded but not flaked.

This number does not include two tools on which abrasion accompanied fracturing, nor tools on which the abrasion extended only slightly beyond the flaking. There was no particular pattern to the edge abrasion. Four tools were abraded along the entire edge opposite the flaked edge -- that is, at the distal flake ends. Three more were abraded only along two-thirds of the edge. The other five varied, showing more or less than one-third of the edge abraded. There was little about the distribution or location of abrasion to the edges of the tool back which was suggestive of patterns, so other aspects and associations were examined.

Invasive abrasion along the edges of the back was found on nine tools, but on three of these, the damage was restricted to one or two ridges or a small sopt. Six showed more extensive areas of invasive abrasion, but on such a small number of tools, correlations were difficult. Two showed abrasion invasive onto the back; three onto the lower face; and two onto the upper face. Except for one tool, this invasive abrasion occurred along the left and/or right third of the back. All of this invasive abrasion was associated with the proximal ends of backing flakes.

There was no shortage of other damage to the upper and lower faces invasive from Edges #2 and #3, but it also appeared to be reandom. There were isolated flakes, both hinged and flat, as well as removals along fracture planes. These flakes and other removals were almost always associated with flaking along the back.

The Phillipsons (their p. 45) report an interesting experiment involving the use of the blunted edge to raise long fibers from bark strips. This produced what I would call light invasive abrasion. They do not, however, report observing this type of damage on geometrics in their site collection.

Intentions aside, the analysis made it clear that the collection of data during microscope examination had not proceeded completely without bias or interference. A low expectation of use-produced damage (expecially for the back of the tool) clearly had some effect upon damage perception and recording. But even more importantly, the damage to Edges #2 and #3, both that related to shaping and to use, was very complex and interrelated. The sort of experimentation and examination necessary in order to form a good idea about the character of damage likely to be associated with retouch would not be difficult, but simply was not possible in the context of this study.

The analysis of damage observed on the blunted backs of geometrics raised some important questions but provided few ready answers. It became clear that retouch experiments should be performed to determine the specific microscopic character of retouch by various methods on the relevant raw materials. The damage observed on an actual sample could then be evaluated with less reference to inference and supposition. To say that edge fracturing is a phenomenon <u>likely</u> to be associated with pressure retouch on hard or brittle materials may be logical but is hardly as compelling as saying it is associated x times out of 100. Thus, although the damage to the geometric back and its edges was considerable, it could not reasonably be separated into categories of cause.

Microscope examination of the upper and lower faces of the forty tools in the study sample produced not noteworthy results. Random striations or non-lithic deposits were observed, but these were very infrequent. One unfulfilled hope of this study was that evidence of hafting might either be present or conspicuously absent or even that distinctly negative evidence might be found. However, the "glossy polish" which the Phillipsons (their p. 45) attribute to unhafted use of tools was not present or else could not be observed at these magnifications. Edge damage did not show any sharply truncated boundaries suggesting protection of the surface by mastic. Lastly, no certain traces of mastic itself were identified. This last point was more intriguing than the others however. Many tools did have traces of apparently non-lithic material adhering to their surfaces, but certain identification was not possible. Indeed, the assertion of the presence of mastic adhering to tools in other studies is a curious phenomenon, as nowhere, to the best of my knowledge, is the precise identification procedure outlined. Considering the extensive cleaning and handling this collection received before examination, the survival of any non-lithic matter must be regarded as surprising. Yet, some did survive and the question is raised of whether there is value in designing a field collection procedure focused on preserving traces of organics as well as ancient damage.

CHAPTER VI

SUMMARY AND CONCLUSIONS

I suppose every researcher is tempted once in a great while to refurbish the patched and coffee stained draft of a completed study and write it up as the brilliant research design, daringly but rigorously executed, that one always hoped it would turn out to be. What a relief to forget or minimize the delays, diasppointments or inadequate strategy and how alluring the prospect of presenting the products of the inevitable compromises and failures as primary objectives. I cannot claim any purity of vision or editorial scruples, but my experience with published accounts of use-damage studies finally convinced me that my mistakes would be as valuable as my successes to someone interested in trying this type of research for the first time.

This study was founded upon a vague idea and a handy artefact collection. The vague idea was that something of interest might be derived from examining some artefacts under a microscope for traces of use. Much time and work served to show that this "interesting something" was very elusive indeed. A survey and comparison of available material on Post-Pleistocene East African prehistory brought out many inconsistencies and deficiencies of research and interpretation in that area which hampered the interpretation of microwear data. A second literature search, into microwear study, revealed glaring disparity in quality, interpretation and evaluation of data and method. The vast majority of the published studies were plagued either by inadequate method, inadequate reporting or both. Perhaps the largest hurdle of all was the immediate need for this author to acquire the proficiency with equipment and technique as well as sufficient familiarity with the visual characteristics of the data to evaluate the quality and utility of previous work.

The specific difficulties and problems which plagued this study and others preceding it have been detailed elsewhere in the text. Despite these problems and the logistical necessity of limiting the analysis to one component of the assemblage, the effort was productive on many levels. Evaluating existing information and interpretations of Later Stone Age materials from "below," that is, from the perspective of the requirements of a microwear study, sharply dramatized the need to have specific kinds of questions answered. Many of these questions are related to artefact context, a problem that is particularly acute for the Post-Pleistocene in East Africa even though there is a steadily growing body of data and interest eroding the deficiency. The difficulties are polarized around two related and mutually interdependent kinds of information. On the one hand, there is a generally shallow, sometimes nonexistent understanding of the complexity of economic activity, resource exploitation, and connections between neighboring groups. On the other hand, the artefacts themselves have been inconsistently and incompletely classified and the relative importance of various kinds and classes of tools either misjudged or ignored.

The questions about the life-ways of East African peoples from the end of the Pleistocene to virtually the present are interrelated and the answers depend upon reestablishing the proper relationships among remaining data. Clearly, the importance of stone tools has been overemphasized at the expense of wood and bone. This and the usual interpretation of those stone tools, has prejudiced our perception of the importance of certain economic activities. We do not really know the relative importance of meat versus vegetal foods and how much human effort was expended on related tasks. The result is that the functions traditionally ascribed to the shaped stone artefacts from this period are probably erroneous. If we wish to know the functions of the objects we recover, we also need to know something about the possible range of economic activities of the people, as well as the full range of raw materials exploited and the character of the physical and biological environment which supported them. Obviously the shaped objects of stone, bone, pottery or even wood, when it is preserved, constitute primary information about economic activities. However, the objects by themselves seldom, if ever, indicate by their character a specific use or the relative importance of that use. Tasks and needs far outnumber the ways bone, wood and especially stone can be suitably shaped. Indeed, there is much evidence that most tools are suitable for several kinds of tasks and that many tasks do not require carefully shaped tools. Likewise, different tasks may produce the same or similar damage on a tool, even at the microscopic level, and use-damage and retouch do not possess inherent characteristics which readily distinguish them. Lastly, one tool may be more or less efficient at its task than another tool at its task. Thus, even if tool morphology and function _were_ invariably related, a high proportion of a certain tool in an inventory might not indicate an important task, but merely a task less efficiently performed. There must be some additional reason to suppose an object to be a knife or a shaper of wood or a weapon beyond our own experience-conditioned responses to shape.[1]

It seems quite clear that tools of wood and possibly bone were very important in Later Stone Age economies and the degree and nature of this importance should be explored. Shaping of wood or bone accounts more efficiently and reasonably for the apparently use-related damage present on microliths than do hunting activities. The nature and tool requirements of other camp activities also need to be explored. Although bones of large game were present at the Rangi site and at many Later Stone Age sites in East Africa, the range of related activities is far from clear. Possibly the animals were killed (although the fact of this and the method is far from clear); almost certainly they were skinned, dismembered and eaten, but what else?[2] It is not easy to be sure. It is not enough to talk vaguely about hide scraping, cutting or piercing without some reason to believe that these tasks were performed at this stie or even at sites in general. As the Phillipsons found (1970), hide "scraping" was virtually ineffective whereas hide thinning, with an edge more like a "knife" than a "scraper," <u>was</u> fast and efficient.

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[1]The problem of function justification cannot be overemphasized. For example, there is a category of modern tools called "knives," and anyone would be able to identify any member of the class as a "knife." Yet knives today are made in an enormous variety of sizes and shapes and calling an item a knife may give only the meagerest amount of information about the task or the economic context of that blade. So it is and worse with prehistoric tools; worse both because of what we do not know about the past and because of what we do know about our present that leads us into the temptation of facile interpretation.

[2]Another nice example of perceptual bias is the typical restriction of hide and skin to the status of "raw material" when in fact there is ethnographic evidence that skin can be a food resource as well (MacCalman and Grobbelaar 1965), our modern distaste notwithstanding.

Just as the probable functions of Later Stone Age microliths differ greatly from traditional conclusions, so also traditional assumptions about hafting and modes of use need to be reexamined. The foundation of the case for hafted microliths rests on their small size, some actual examples of hafted microliths from unrelated geographical regions and some apparent cases of mastic or gum still adhering to small tools at various northern and southeastern African sites. Neither this study nor the Phillipsons' presented any positive evidence of hafting and the Phillipsons may have discovered some negative evidence, namely, the light surface polish which they associated with heavy or long-term, hand-held use.

A last, but not less important, difficulty in determining the probable functions of the tools studied here arises from the current range of classification schemes and their internal problems. These have been discussed at length above and it is not necessary to recapitulate them here. The need to explore the relationship of use-damage to form led to a morphological analysis of this collection rather than an imposition of any of the schemes developed for other assemblages. This internal analysis did not result in any validation of conventional shape distinctions imposed on microliths. The strongest differences and modalities appeared in morphological components not usually included in classifications. The most basic morphological subdivision of microliths was between single- and double-pointed items. Other characteristics seemed to follow this distinction as well. A final indication of this study and others was that the variation in sharp edge plan, profile and character may have been subject to more stringent functional requirements than the variation in the back.

As an extension of the morphological analysis, the data on item dimensions were summarized and examined. In general, the results of this analysis bore out the dichotomy between single- and double-pointed items, while no support could be gleaned for the traditional breakdown of double-pointed shapes. A most interesting result was seen in the differences displayed by snapped and unsnapped items conventionally lumped into the category "backed blades." There was virtually no difference in height and thickness variation while the difference in length variation was marked. This suggests that many snaps are breaks rather than intentional shape components. In terms of single-pointed items, dimensional analysis did not elucidate the relationship of so-called J-shaped items to backed blades which they closely resemble. In a further effort at functional analysis, this would have to be explored. One of the most important results of the dimensional analysis was the clear utility of the data for interpretation of microlith variation. The complexity and consequent need for careful interpretation (well illustrated by the L/H relationship) was also clear.

The microscope examination of artefacts was begun and nearly finished before the data on morphology and dimensions was completely gathered and analyzed. Therefore, the choice of items to be included in the sample was somewhat arbitrary, governed only by some vague idea of examining the patterns of damage in relation to conventional shape classes. The concept of "patterns of damage" seems easy to grasp until microscopic reality dashes illusions. An elaborate classification of damage by type was devised for this study whose utility will only be proven by further work. • The types of damage included were those observed on the artefacts studied, but the list could certainly be modified, including expansion of subsumation of individual types to lower or higher-level attributes. Until the relationships of damage patterns to kinds of usage are much better understood, this lower level approach to data gathering seems to offer many advantages.

Even so, forming conclusions about patterns of damage on microliths was seriously hampered by the inability to distinguish conclusively between damage associated with use and with retouch. Others have noted this problem and any further work involving microliths should deal with it. A solution would be emminently approachable through simple experiments. It should be clear that I offer my conclusions about damage patterns and location with the warning that, in part, they are based upon some logical assumptions which need to be validated by further experimentation and research.

The primary insecurity is about damage to the retouched back. The frequent scraper-like character of the back as well as contrariness and a compulsive need for analytic exhaustiveness, led to an equal consideration of the back and sharp edge as loci for damage. The most common kinds of damage found on the back are flaking, fracturing and abrasion. Other kinds of damage include a variety of snaps, breaks and removals along fracture planes about which little can be said due to the size and nature of the sample. The data and my impression after hours of microscope time is that the bulk of the flaking is due to intentional attempts at blunting and that the fracturing is a product of the technique used. The character of the abrasion, however, suggested possible association with use. It was occasionally invasive, extending onto the back or, infrequently, onto the adjacent face, along ridges and prominances.

In other words, it appeared to overly and could thus be subsequent to other damage. In addition, it varied in intensity over flaking and/or fracturing which did not vary. This indicates a possibility, which could easily be explored, that the backs of these tools sometimes functioned in contact with worked materials.

The analysis of damage to the sharp, unretouched edge had more dramatic results. It was, of course, not possible to do more than suggest a reange of activities which could account for the observed damage. However, the patterns of location and type of damage were <u>strongly</u> suggestive of particular modes of use. The most common mode of use could be called "whittling." In this motion, the tool is either pushed or drawn at a low angle and perpendicular to its length axis upon the surface of the worked material. Most of these tools show total involvement of the sharp edge. This could be attributed to reciprocal use or to holding (of hafting) the tool so that the entire edge contacts the worked material at once. Another kind of "whittling" motion displayed involved only two-thirds to one-half of the sharp edge, but was otherwise the same. In this case, the direction of movement was probably at a slight angle, between 50^{o} and 90^{o}, to the length axis. Another common pattern of damage was attributed on the basis of experiments by the Phillipsons (1970) and others to a reciprocating motion in a vertical position, as in making a vertical cut. All of these usage modes are suggestive of manufacturing processes involving wood or bone and perhaps some butchering activities as well. However, there is no justification for making further ascertions about specific tool functions until experimentation and research provide more clearly defined activities and activity requirements at these sites.

Another use mode frequently ascribed to these tools and actually displayed here involved heavy damage confined to the pointed tips of the tools. There was no particular relationship displayed between this pattern and others, but that could be a function of inadequate sampling. The damage did not have the characteristics of drilling (described by Semenov 1964) or any particular indications of how the points came to be flaked and abraded, but the Phillipsons (1970) on the basis of experiments and other evidence ascribe this phenomenon to piercing, especially of raw hide.

My data did not produce evidence suggestive of the nature of links between usage modes and important morphological differences. This is probably related to the way items were selected for inclusion in the study sample and could easily be rectified in another study.

The examination of artefacts for traces of utilization, especially microscopic traces, was the original focus for this study, but in the end proved to be no more and no less important than other components of the effort. In such a situation where function cannot be presupposed, mutually supportive data are essential. Though it is not clear that they cannot, Later Stone Age sites have seldom provided sufficient information for precise definitions of activities with which artefacts could be correlated. Likewise, analogous ethnographic data is both meager and meagerly applied. Thus conclusions must be drawn from converging lines of supporting evidence supplied by the artefacts themselves. This is, of course, pure hindsight. Most of the questions about microliths whose answers seem important to me now were generated by this study. I cannot offer dramatic new conclusions about the functions of geometric microliths, but I can say that traditional ascriptions of function, and, indirectly, of economic strategy are almost certainly quite wrong. The role of hunting, hunting strategies, and hunting equipment in East Africa for this time period all need serious reconsideration.

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