Microliths Typology and Technology of the Upper and Epipaleolithic transition period, Jordan[1]

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Abstract. *For the past 50 years, the division between the Late Upper Paleolithic and Early Epipaleolithic has depended on perceptions of lithic typological variation. For example, backed microliths were considered temporal markers for the Epipaleolithic; Ouchtata bladelets were thought to mark the Late Upper Paleolithic. This research examines lithic assemblages that date to the 22-17 kyr BP collected from thirteen sites in Jordan. The analysis suggests patterns in lithic technology, typology, raw material procurement, subsistence, and site distribution, especially as the latter relates to mobility.The morphological and the metrical attributes of microlith types strongly suggest that these types correspond to manufacturing stages. Additionally, this research shows that backed microliths and Ouchtata bladelets are present at the same time (c. 22-15 kyr BP) and same sites. That their ratios differ from one site to another is probably due to site function rather than to the stage at which they appeared.*

Introduction

The transition between the Upper Paleolithic and the Epipaleolithic, approximately 20,000 years ago, has been widely recognized in the prehistory of the southern Levant. Generally, the transition is identified on the basis of typological systematics which are often used by convention or for convenience, without any demonstrable relationship to a problem or a hypothesis. The typological systematics used in the Levant are derived from French models and constructs that date to the seminal works of the late François Bordes in the 1950s and 1960s (and, ultimately, to late 19th - early 20th century French paleolithic systematics). The logic underlying these approaches has not changed in almost a century. They are based on the implicit notion that processes in remote time are equivalent to processes in recent contexts, and that it is reasonable to expect patterns derived from the analysis of archaeological data to be explicable by invoking the same kinds of entities and processes observed historically. Paleolithic archaeology thus becomes a kind of history, but one projected far back into the remote past (Clark 1993). Whether or not it is reasonable to do this (i.e., treat paleolithic archaeology as 'history-like') is only infrequently called into question.

Clark has suggested that conventional typological systematics are replete with unstated assumptions, biases, and preconceptions about what patterns might mean, and are very limited in what they can tell us about the behavior of prehistoric foragers (e.g., Clark 1989, 1993, 1994, Clark and Lindly 1991). In order to account for the range of variability evident in Upper Paleolithic and Epipaleolithic assemblages, a new conceptual framework has recently been developed for the Levantine Upper Paleolithic and Epipaleolithic: it deemphasizes typology and focuses on general situational variables with which all foragers must contend (Barton et. al.1996; Neeley and Barton 1994). Proceeding from the general conceptual framework of community ecology (e.g., Kuhn 1995, Smith and Winterhalder 1992, Stiner 1994), this approach calls into question many of the assumptions that are implicit in conventional typological systematics. It can be viewed as an alternative conceptual framework to the one underlying the typologi-

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cal approaches that are commonly used in the area today.

In this research, I propose to examine the archaeological assemblages that date to the 22-17 kyr BP Upper Paleolithic-Epipaleolithic transition interval in Jordan in order to assess patterns in lithic technology, typology, raw material procurement, subsistence, and site distribution, especially as the latter relates to mobility. This interval spans the last 2-3 millennia of the Upper Paleolithic and the first 2-3 millennia of the Epipaleolithic as conventionally defined. The research will make use of both published data and personal examination of collections stored in museums in Jordan, the United States, and England. These collections are often assigned on typological grounds to a number of supposedly-distinct assemblage types, which initially will be retained as analytical units. The intent of the research is to see whether there is any correspondence at all between these named assemblage types and multivariate patterns identifiable according to the above-stated variables. A secondary objective is to see whether there is any evidence of a behavioral division that corresponds to the conventionally defined Upper Epipaleolithic boundary at 20 kyr BP. The logic of inference is identical to that underlying the systematics used to define the Upper Paleolithic in the Levant and Europe. However, the Upper Paleolithic in the Levant dates, according to radiocarbon chronologies, to c. 45-20 kyr BP, whereas the Upper Paleolithic in Europe dates to c. 40-12 kyr BP.

Systematics in Old World Paleolithic Archaeology

At the level of the metaphysics, or the most overarching conceptual framework, there are two paradigms that determine differences in stone artifacts through space and time and what they might mean; these are: (1) the traditional culture-historical paradigm formalized by François Bordes (1951) and known as the Old World paradigm, and (2) the functionalist or behaviorist New World paradigm described by Lewis Binford (e.g., 1979, Binford and Sabloff 1982).

Old and New World Paradigms Compared

The typology of Old World chipped stone assemblages, including those of Epipaleolithic, has been systematized according to Bordes' traditional paradigm. The traditional Old World paradigm stresses the importance of distinct classes of stone tools. It suggests that morphology is discrete, predetermined and corresponds to mental templates. Also, it emphasizes that these stone tools carry information relating to social identity, which can be discovered by archaeologists. Binford, conversely, suggests that morphological variability is primarily the result of functional differences between artifact use contexts (and other factors, like raw material) rather than the result of the stylistic differences emphasized by Bordes (1951). Harold Dibble's work (1987, 1995) on Middle Paleolithic side-scrapers discussed both paradigms, and emphasized the importance of generalizable aspects of lithic reduction sequences and the effects that blank size and shape had on tool form, the extent to which tool form could be modified and, in consequence, what was finally discarded. He emphasized that what is recovered from archaeological sites is discarded, used-up, worn out and/or broken, and draws attention to the 'Frison effect'. Frison (1968) argued that artifact morphology of the stone might change through life use because of resharpening and rejuvenation. As a result, what is recovered from archaeological sites is not necessarily the original shape of the artifact. According to this notion, the resharpening sequence was initially conditioned by the shape of the original blade or flake and subsequently by its life history, rather than a reflection of predetermined, idealized tool forms (Barton 1991; Dibble 1995).

The advantage of the typological system upon which the Old World paradigm is based is that it allows the systematic comparison of the whole artifact assemblages widely separated in space and time. The traditional paradigm, however, concentrated on the end product of a small part (usually < 5%) of paleolithic assemblages, the retouched stone tools, and neglected the manufacturing, maintenance, and discard process. As a result, it is very limited in what it can tell us about past human behavior (Barton 1991; Clark et. al. 1997; Coinman 1998).

Levantine Researchers Mostly Trained in Europe.

As subscribers to the Old World paradigm, most Levantine researchers tend to believe that changes in lithic typology and technology are linked, and that changes reflect ethnic differences in some vague and imprecise way. They think that morphological variability in stone tool technology reflects learning in a social context which correlates with discrete ethnic groups, at least for the Upper Paleolithic and Epipaleolithic. For example, Bar-Yosef (1989) interprets the secondary trimming techniques for microliths as reflecting 'schools of knapping', thus carrying social information, whereas differences in microlith shapes resulted from variable hafting methods and stylistic variability. Both hafting methods and stylistic variation in retouch methods convey social information (Bar-Yosef 1981; Goring-Morris 1987; Henry 1983), although when hafted most of the attributes become invisible. It is, therefore, assumed that additional stylistic attributes were expressed in the visible parts of these multicomponent tools (Bar-Yosef 1987, 1989). However, as Clark has pointed out repeatedly (e.g., 1989, 1993, 1994), morphological variability between typological categories does not necessarily reflect social boundaries. Changes in typology could reflect technological differences (i.e., manufacturing processes which include production and reduction processes) that cross-cut, or behave independently, of social boundaries. These technological differences are also clearly affected by environmental constraints and raw material availability. Therefore, the technology of lithic artifacts likely reflects settlement strategies, and the relative degree of mobility, since there is a consensus that settlement strategies are set according to environmental constraints (specifically, the distribution of food resources, water).

Epipaleolithic Systematics

The Epipaleolithic was originally defined almost exclusively on typological grounds by the appearance of microliths as a dominant portion of the retouched components of lithic assemblages (Donaldson 1991). Microliths are the replaceable elements in the multicomponent tools. There are many ideas about why 'microlithization' took place; among the more convincing of them is Torrence's (1983) notion of time-stress which linked it to increased mobility and dispersal of resources in the landscape that coincided with the last glacial maximum.

Epipaleolithic assemblages manifest a wide range of spatial and temporal variety. Chronological changes in lithic production techniques may account for much of this variability (Olszewski et. al. 1990). Some Old World researchers argue that some typological diversity is due to cultural differences between groups of people (e.g., Bar-Yosef 1970, 1989); still others relate it to the process of artifact reduction and maintenance itself (e.g., Coinman 1997 1998; Neeley and Barton 1994). In Jordan, the Epipaleolithic period has nine recognizable lithic industries and phases such as Qalkhan, Hamran, Madamaghan, or Natufian. If the eastern and western Levant were to be combined, there would be a total of eighteen industries. With the exception of the Natufian, there is disagreement amongst various researchers on the use of this terminology (Olszewski 1997). Although the systematics of the classification framework are still being developed, new sites and areas within Jordan are currently being investigated in greater detail. This situation has led to several, temporary compromises. For example, Byrd (1994) recognizes specifically named tool types such as Qalkhan points and La Mouillah points, but chooses to classify assemblages with these and other non-geometric forms of microliths from the Azraq region as 'Non-Geometric Microlithic'. Neeley et al. (1998) follow a similar approach by using 'non geometric' and 'geometric Epipaleolithic' for assemblages in the eastern third of the Wadi al-Hasa area (Neeley 1998). Geometric microliths are used to distinguish the Geometric Kebaran from the Kebaran, although what these differences mean in behavioral terms is not clear. Another example is the Madamaghan, proposed by Henry (1995) for the Ras en-Naqb area and linked by him to industries of the Mushabian Complex of the Negev and Sinai. Although he defined this industry at the site of Tor Hamar, he chose the site of Wadi Madamagh near Petra as the type-site. Because the assemblage from Wadi Madamagh is similar to these from the Wadi al-Hasa and Azraq Basin, Olszewski (1997) chooses to use the term Madamaghan, rather than linking it to the Mushabian Complex of the Negev and Sinai.

The Upper-Epipaleolithic Transition

The term 'Late Upper Paleolithic' was first used by Ferring (1977) to describe assemblages from the central Negev highlands. Goring-Morris (1987) introduced the term 'Terminal Upper Paleolithic' to refer to pre-Mushabian/ Geometric Kebaran assemblages in the Negev and Sinai (Gilead 1991; Goring-Morris 1987). The coexistence of the 'Epipaleolithic' and 'Late Upper Paleolithic' microlithic assemblages, and the use of different terminologies for the transitions (e.g., 'Terminal Upper Paleolithic', 'pre-Kebaran' and 'Late Upper Paleolithic') reflect this conceptual ambiguity (Gilead 1991). This and other terminological confusions related to the 'Kebaran' and the 'Early Epipaleolithic' (with all their many subdivisions) indicate a lack of understanding what the transition meant, and how the different groups interacted (or not) over time ('groups' here does not imply ethnic distinctions; it simply refers to undefined groups who lived in the 22- 15 kyr BP interval).

For more than 50 years, Levantine researchers have created terms to describe the period after the Upper Paleolithic. These terms depended mostly on lithic techno-typological analyses, which played major roles in distinguishing the Epipaleolithic period and the diversity within it (Byrd 1994). Among the most confusing is the definition of the Epipaleolithic itself and the overwhelming role that lithic analysis has come to play in understanding the diversity within the period. Donaldson (1991) discusses the idea of whether the whole Epipaleolithic period is a transition between the Upper Paleolithic and the Neolithic, or whether the transition took place only in the last 3000 years of that interval. Other terminological difficulties involve implicit economic and social dimensions of highly mobile foragers, which are not strongly correlated with typology. While the early Epipaleolithic appears to be an extension of the Upper Paleolithic, the late Epipaleolithic exhibits a range of characteristics that separate it from 'typical' Upper Paleolithic hunting and gathering adaptations (Donaldson 1991).

Sources of Microlith Variation Linked to Paradigmatic Bias.

There is clear disagreement among Old

World researchers about the Early Epipaleolithic terminology. These disagreements cause confusion that needs to be cleared up. By studying the similarities and differences between the collections in this study, terminological agreement may be reached at least for the Jordanian Epipaleolithic sites.

Goring-Morris (1995, 1987) believes that what he terms Epipaleolithic stylistic characteristics (morphology, metric dimensions, and retouch) already existed in the Upper Paleolithic, although in a much smaller degree (Goring-Morris 1995). According to Goring-Morris, one of the major distinctions between the Upper and the Epipaleolithic is the growth of territoriality after 20 kyr BP. However, the microlith categories, invented by archaeologists to help analyze these tools, were not necessarily part of the mental templates of people long dead. In all likelihood the Upper Paleolithic and Epipaleolithic people did not think of these microliths as discrete types. The logical question is, over any given time interval, why certain types appeared in one area and not in others. Some researchers (e.g., Goring-Morris, Henry, Bar-Yosef) argue that this is because of the different ethnicities (so the 'divide' is not exclusively between archaeologists trained in the Old World vs. those trained in the New).

As a solution for the terminological problem, Gilead suggested that Old World researchers should lump together the industries that fall between the Late Upper Paleolithic and the Natufian and include them in the Upper Paleolithic (1991). Treating this era as a continuous period, without a breaking point, is reasonable enough; however, it is important to be able to recognize developmental and technological differences between assemblages and to understand their environmental implications. Typological differences should be used as analytic instruments rather than as stylistic, group identifiers. Nevertheless many researchers still consider microliths as a criterion to differentiate the Upper from the Epipaleolithic; Bar-Yosef (1991) still considers microlithic 'styles' the best way to define regional traditions and group boundaries. He understands that there is uniformity in the shapes of microliths in the 'Kebaran Complex' based on quantitative and qualitative analyses. His assessment of the shapes separates the 'Kebaran Complex' from both the earlier Upper Paleolithic and the later Geometric Kebaran. Microlith morphology and hafting techniques are used by Bar-Yosef (1989) and others to trace 'changes' through space and time. For example, Bar-Yosef (1989) considered the differences between the obliquely backed truncated microliths and the trapeze as an example of technological change through time. Unfortunately, he did not define what he means by 'changes'. 'Change' might mean an indication of ethnicity (difference between groups) or technological change through time within a single group. The difference between these two types, however, could also be a functional difference. Still, the difference might be that the obliquely backed truncated bladelets are actually unfinished trapezes. These potential explanations could be sorted out by use-wear studies, (i.e., determining which edges were used and for what-- cutting plants, butchering animals, etc.). Use-wear studies would also allow us to determine whether a bladelet was used in a haft or as a point.

Variation in microlithic morphology evidenced from the excavations at sites in the Azraq Basin, southern Jordan, and the western Negev force a re-evaluation of the Kebaran assemblages. Because many researchers argue that each period must have microliths of predetermined shapes, quantitative and qualitative analyses, along with in-depth interpretations of sites, are constrained.

Difficulties with using retouched bladelets as criteria to distinguish the Upper Paleolithic from the Epipaleolithic have been thrown into sharp relief because of (1) the recognition that bladelet blanks and retouched bladelets are common even in the earliest Upper Paleolithic sites dating to c. 38 kyr BP (Bar-Yosef and Belfer-Cohen 1977; Gilead 1991; Phillips 1994), and (2) the appearance of sites with lithic industries with very few backed bladelets that both pre- and post-date 20 kyr BP. These sites mostly show up in the southwest Levant (Byrd 1994). Such sites point to continuity in the life style of Upper Paleolithic hunter-gatherer groups (Byrd 1994). These two discoveries have led Old World researchers to re-evaluate and treat the term 'Epipaleolithic' differently. Gilead (1984, 1991) recommended that 'Epipaleolithic' term should be restricted to the Natufian. Bar-Yosef and Vogel (1987) restricted the term to the Geometric Kebaran. Others argued for dropping the term altogether (e.g., Byrd 1994, Goring-Morris 1987, and Henry 1989).

The preconception that ethnicity is 'writ small' in microlith styles and technology has caused some Old World prehistorians to focus on microlith shape, size, the type of retouch, and the incidence of the microburin technique. However, much of the variation in microlith morphology and frequencies could be attributed to functional differences, and to differences in the methods used to mount them on wood or bone shafts armatures (Bar-Yosef 1987; Kukan 1978; Valla 1987).

Methods and Analyses

This research examined lithic assemblages that date to the 22-17 kyr BP interval; they have been collected from three main areas in Jordan: Azraq Basin (Eastern Jordan), Wadi al-Hasa (Central Jordan), and Ras en Naqab (Southern Jordan) (Fig. 1). The primary intent of the research is to determine whether there is any correspondence between these named assemblage types and the multivariate patterns identifiable according to the variables given below. A secondary objective is to determine whether there is any evidence of a behavioral division that corresponds to the conventionally defined Upper-Epipaleolithic boundary at 20 kyr BP. As far as the conceptual frameworks are concerned, the systematics used to define the Upper Paleolithic and Epipaleolithic in the Levant and Europe are virtually identical. However, it is worth remarking that the Upper Paleolithic in the Levant dates, according to radiocarbon chronologies, to c. 45-20 kyr BP, whereas in Europe this period dates to c. 40-12 kyr BP. Thus the Levantine Epipaleolithic (post 20 kyr BP) corresponds to the Late Upper Paleolithic in Europe.

Metrical Analyses: Metrical analyses of technological variables are used to measure the variability of lithic attributes (for both tools and blanks). The measurement of blanks provides an understanding of the broad outlines of technological change in the region. In addition, it offers a common framework for the understanding of both technological and morphological attribute variation.

Recording Methods: The system used to record the artifact attributes was a data entry application developed in Microsoft ACCESS, database management system. The microlith typology used in this research is a descriptive one. For the purpose of this research, the most common tool categories were geometric and non-geometric microliths. Each end of the microliths was recorded separately. In addition, retouch modes (abrupt, abrupt/anvil, fine, Ouchtata, etc.) were recorded for each geometric and non-geometric type.

Attribute data from the various collections were recorded as completely as possible, ac-

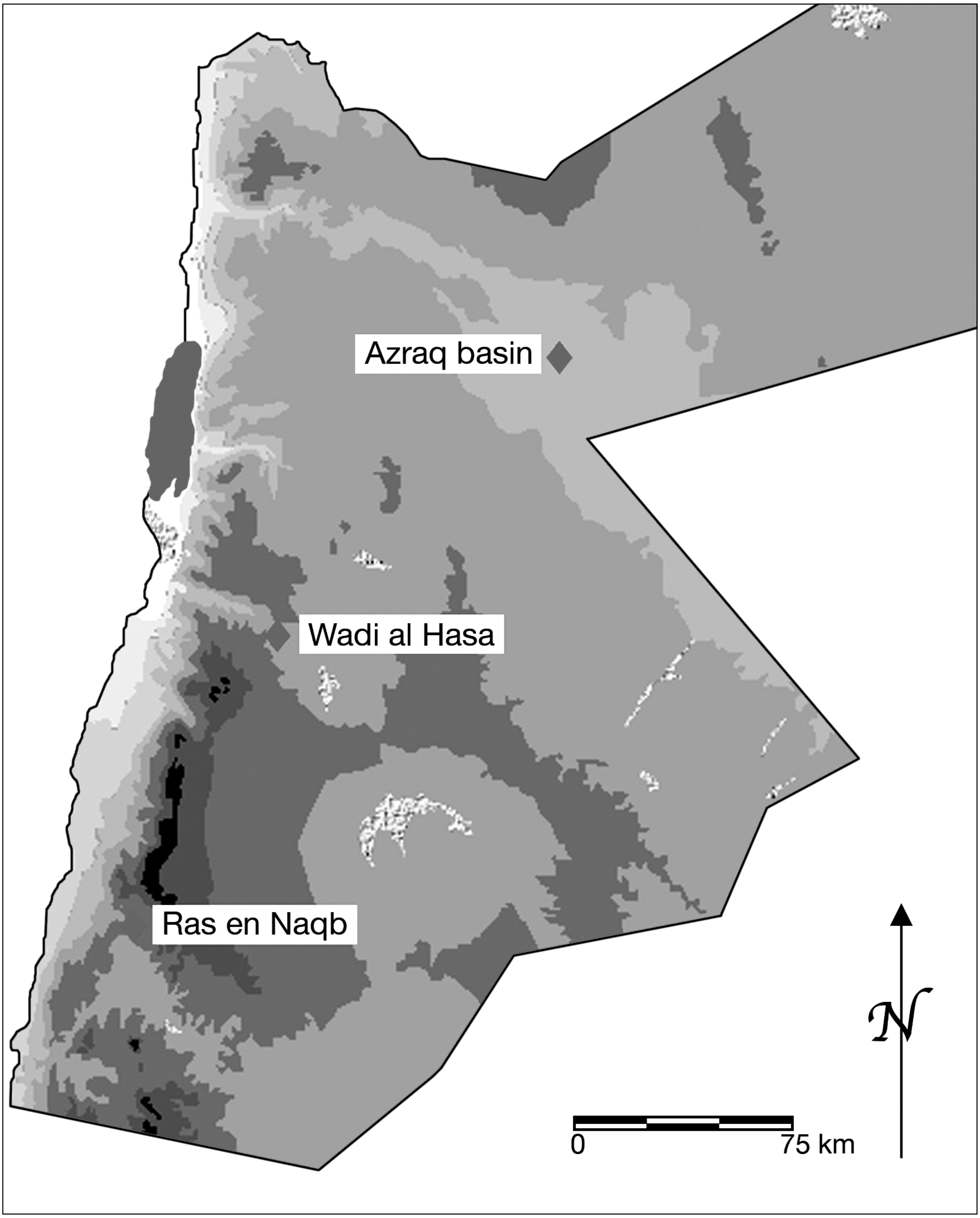

Figure 1: Jordan study areas.

cording to what was available to me. Categories recorded at each site were as follows: Tor Sageer (WHNBS 242), all artifacts were recorded; Tor al-Tareeq (WHS 1065), Step B only; Yutil al-Hasa (WHS 784), Tests A, B and C; Ain al-Buhira (WHS 618) Tests H-I; J406, Area b, and J431 E2 (Lower), data on bladelet blanks, cores, and tools (geometric, non-geometric) were recorded. For Jilat 6 (Phase III), Uwaynid 14 (Trenches 1, 2), Uwaynid 18 (Trenches 1, 2), and Azraq 17 (Trench 2), only the geometric and non-geometric tools were available for study. Additional information pertaining to Ain al-Buhira (WHS 618) was generously provided by Nancy Coinman (pers. comm., 1999). All other data not personally collected were generated through the analysis of published reports.

Discriminant Function Analysis. Discriminant analysis and classification are multivariate 'pattern searching' techniques designed to separate objects (cases) into groups, to assign new objects to groups previously defined, and to assess the statistical probability that new objects actually pertain to the groups to which they are assigned. The nature of the discriminant analysis is exploratory. The separation procedure identifies the variables that are important for distinguishing among the groups when causal relationships are not well understood. The classification proceeds by forming a linear combination of independent variables (predictors) that serve as the basis for classifying cases into one of the groups. The classification procedures lead to well-defined rules that minimize the probability of misclassification (which is, however, also expressed statistically). These algorithms can be used to sort and assign unknowns optimally into new groups (Norusis 1988, Johnson and Wichern 1982).

The rationale for running these multivariate pattern searches was to examine the structure of the traditional microlith classification system in order to gain a better understanding of the relationships between the different shape types and the metrical attributes, on the one hand, and to try to reclassify the microliths/retouched bladelets accordingly, on the other.

The independent variables for complete microliths/retouched bladelets were: length, width, and thickness. For the entire inventory of microliths/retouched bladelets, only the width and thickness were used as independent variables. In both cases, the types were used as grouping variables.

The results of the analysis succeeded in determining which independent variables had the most significant effect on distinguishing among the types. However, variation in sample counts resulted in assigning most of the types to one or two type categories. Unsurprisingly, these two types had the highest sample frequencies which, in turn, affected the analysis negatively in that there was a high probability of a sample error effect. For this reason the second part of the analysis is ignored.

The following tables and figures were produced to assist this research:

1. Typology table: Table (1) summarizes combinations for both ends on single complete microliths from all sites in aggregate. Table (1) and Figure (2) show the attribute relationships between different 'overall' shapes of microliths and the combinations between the two ends in a single microlith. My purpose in creating this table is not to create a new typology, but to offer a new approach to the old typology, an approach that might make it more realistic and, in consequence, might allow us to use it more effectively.

2. Microlith and Retouched Bladelet Percentage (Figures 3, 4 and 5).

3. Artifact and Tool Percentage (Figures 6 and

7).

4. Artifacts Density (Figures 8 and 9).

5. Microlith and Retouched Bladelet Metrical. (Figures 10, 11, 12, 13 and 14).

Discriminant Function Analysis

Running the discriminant analysis helped to determine the metrical attribute combinations best able to distinguish typological groups. Width is the independent variable that best distinguishes the different types. For all the microlith/retouched bladelets, including both complete bladelets and fragments, Table (2) shows that 80.8 % of the variance is explained by the first function. The first function is based primarily on width. The second function, based on the thickness, explained 19.2 % of the variance.

BACKED BLADELETS	**I. Oblique ends**		1	Backed Double Oblique Truncation
			2	Backed Double Oblique MB scar
	II. Convex ends		1	Backed Double Convex Truncation
			2	Backed Double Convex MB scar
	III. Straight End		1	Backed Double Truncation
	IV. Pointed		1	Double Pointed
			2	Qalkhan Points
	V. Combinations		1	Backed Oblique Trunc/ Convex Trunc
			2	Backed Oblique Trunc/ Convex MB scar
			3	Backed Oblique MB scar/ Convex Trunc
			4	Backed Oblique MB scar/ Convex MB scar
			5	Backed Oblique MB scar/ Pointed
			6	Backed Oblique Trunc/ Pointed
			7	Backed Convex Trunc/ Pointed
			8	Backed Oblique MB/ Convex point
			9	Oblique Truncation/ Pointed
			10	Backed Oblique Trunc/ Oblique MB scar
			11	Backed Convex Trunc/ Convex MB scare
	VI. Unmodified	**A. One end**	1	Pointed
			2	Backed Obliquely Truncated
			3	Backed Convex Truncated
			4	Backed Straight Truncated
			5	Backed Oblique MB scar
			6	Backed Convex MB scar
			7	Oblique Truncation
			8	Narrow Point
			9	Backed Convex Point
		B. Two ends	1	Backed Bladelet
RETOUCHED BLADELETS	1	Ouchtata Bladelets		
	2	Dufour Inverse Retouch		
	3	Dufour Alternate		
	4	Not Dufour Inverse Retouch		
	5	Not Dufour Alternate Retouch		

Table 1: Typology Table List.

For the complete microlith/ retouched bladelet sample, Table (3) indicates that 77.4 % of the variance is explained by the first function, which is based primarily on width. The second function, based on length, explained 14.5 % of the variance. The third function, based on thickness, explained only 8.1 % of the variance.

In sum, the results of the discriminant analysis suggest that width is the most meaningful measurement to distinguish different types. This is especially true when width is used in conjunction with technological and morphological attributes. For this reason the metrical analysis in the following sections will be based mainly on width.

Metrical Analysis of Microlith/Retouched Bladelets

Complete Microliths. The metrical attributes of the complete microliths (all complete microliths from all sites combined) are listed in Table (4) and the variables illustrated in Figures (10, 11 and 12). Length, width, and thickness and their frequencies, means, standard deviations, and range (minimum-maximum) are also given in Table (4). It was noticed (Table 4) that the standard deviation and range for length across all types were both relatively large. Some types had small sample sizes, which were not reliable enough to be taken into account to determine the metrical attributes of the types. On the other hand, some types had medium and large sample sizes that created a clearer picture of their metrical attributes. The following types are related to each other metrically and are distinguished from most of the other complete types in the collection:

(1) Convex end 1 (backed double convex truncated) has the largest sample size of the entire complete microlith collection. Considering the sample number and the pattern in the standard deviations, it appears that the width of this type is highly standardized (Table 4, Figure 10, 11 and 12).

(2) Ouchtata bladelets are the next largest sample of the collection. The relatively large standard deviation for length suggests that the width of the Ouchtata bladelets is more standardized than the length (Table 4, Figure 10, 11 and 12).

(3) Combo 11 (backed convex truncated/ backed convex with microburin scar), Convex ends 2 (backed double convex microburin scar) and Oblique ends 2 (backed double oblique microburin scar) seem to be related to each other in terms of their metrical attributes (Table 4, Figure 10,11 and 12). This indicates that they are related to

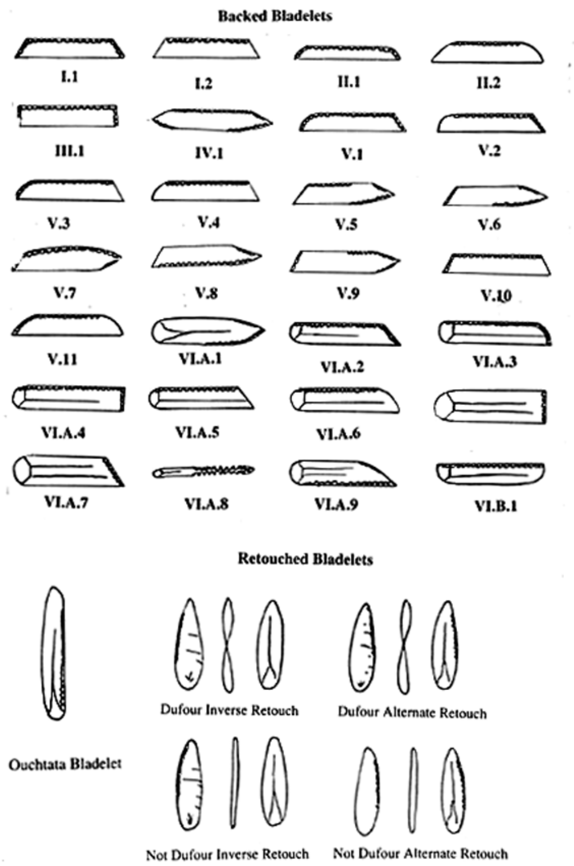

Figure 2: Typology Shapes.

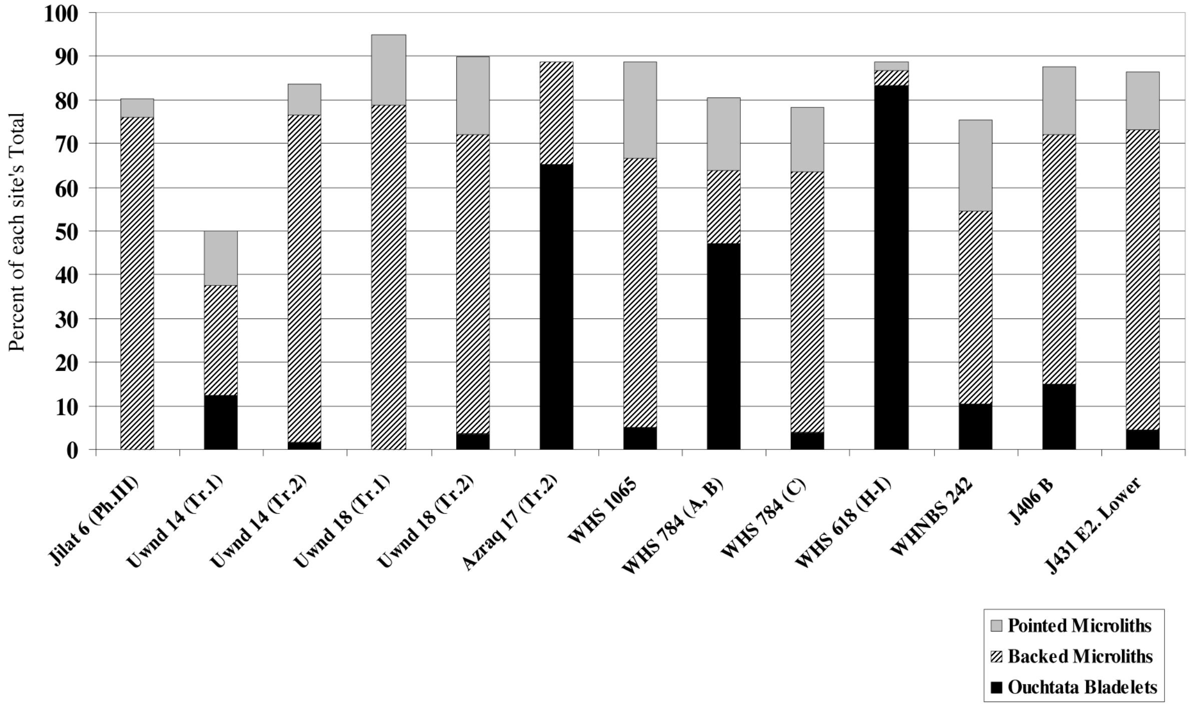

Figure 3: The Percentage of Ouchtata Bladelets, Backed Microliths and Pointed Microliths Across Sites.

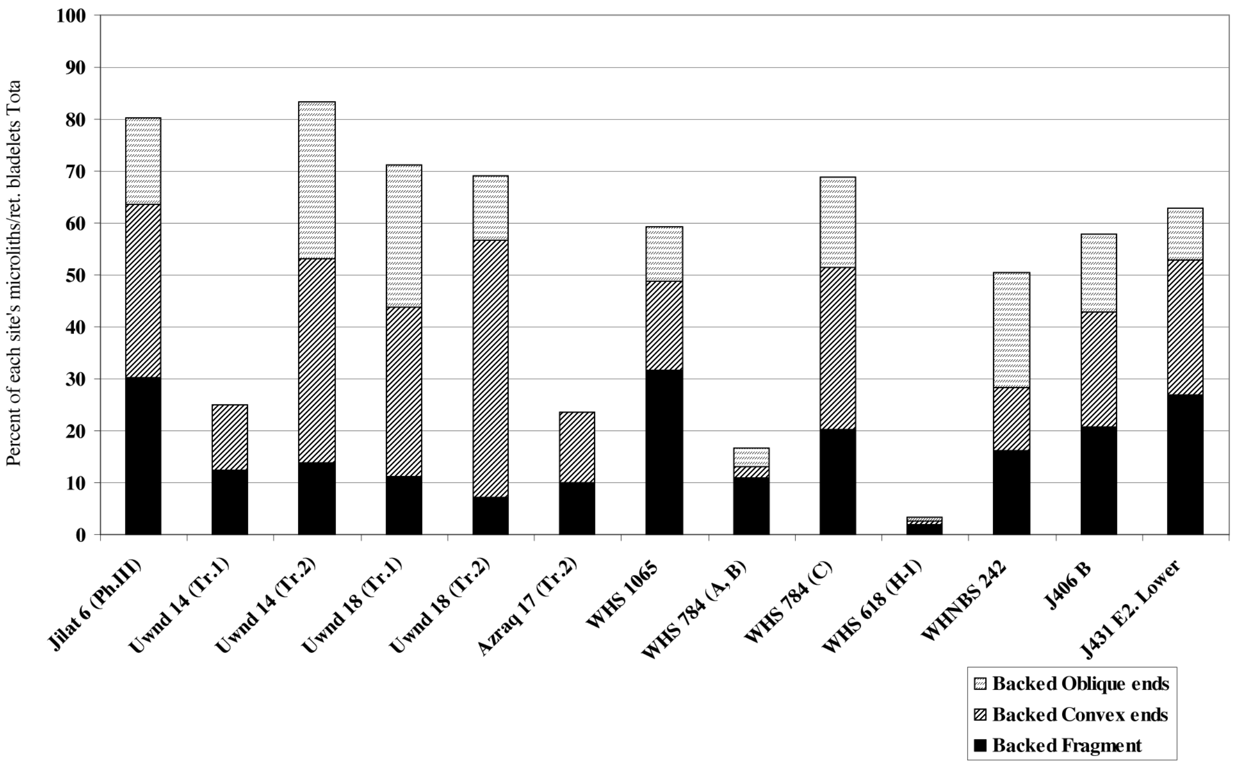

Figure 4: Microliths' Ends Shapes Between Sites.

Table 2: Summary of Canonical Discriminant Functions for All Microliths (Complete and Broken).

EIGENVALUES

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.509	80.8	80.8	.581
2	.121	19.2	100.0	.329

a First 2 canonical discriminant functions were used in the analysis.

Structure Matrix

	Function	
	1	2
Width	.933	.359
Thickness	.150	.989

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions Variables ordered by absolute size of correlation within function.

• Largest absolute correlation between each variable and any discriminant function

Table 3: Summary of Canonical Discriminant Functions for Complete Microliths

EIGENVALUE

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.364	77.4	77.4	.760
2	.256	14.5	91.9	.452
3	.143	8.1	100.0	.353

a First 3 canonical discriminant functions were used in the analysis.

Structure Matrix

	Function		
	1	2	3
Width	.968	-.085	.235
Length	.424	.781	.458
Thickness	.298	-.061	.952

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions Variables ordered by absolute size of correlation within function.

• Largest absolute correlation between each variable and any discriminant function.

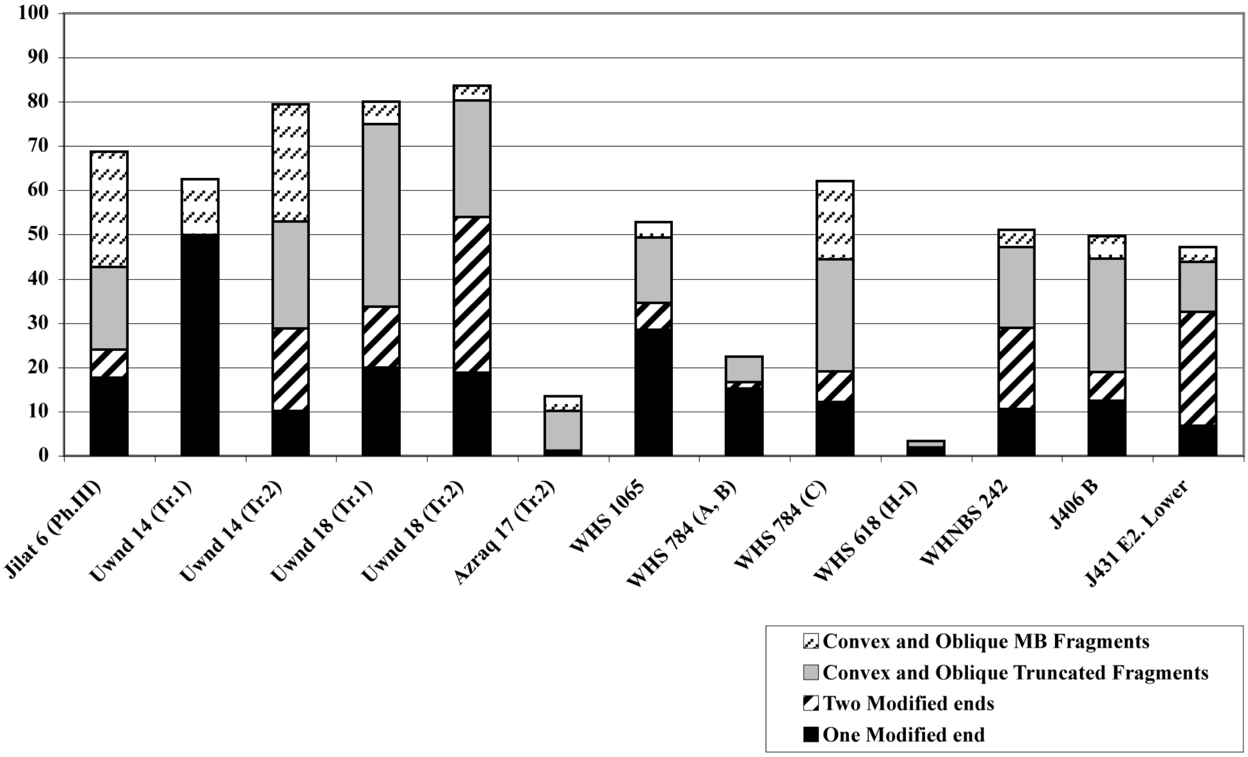

Figure 5: Backed Microliths Types Across Sites.

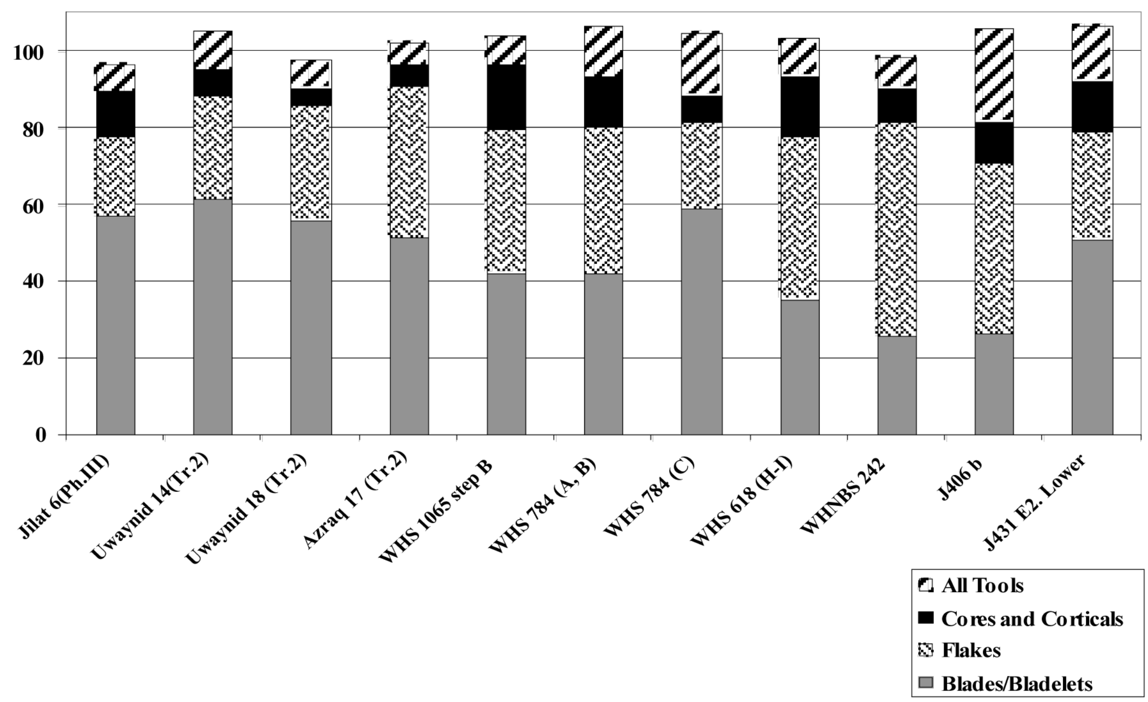

Figure 6: All Major Artifact Percentages Type - by Site.

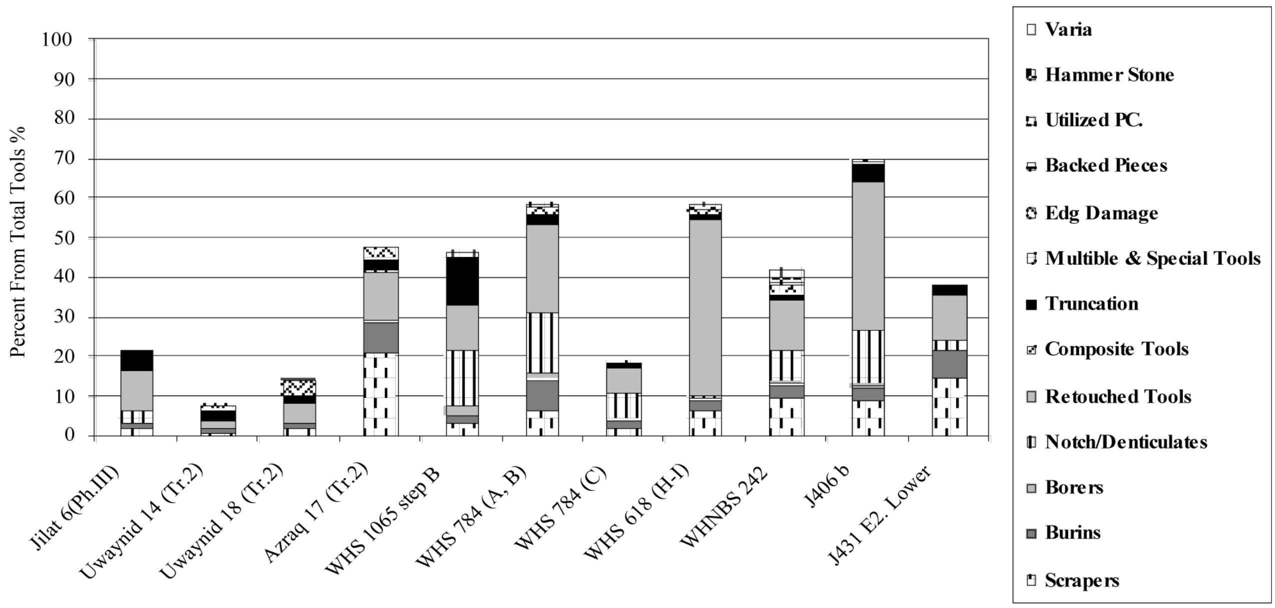

Figure 7: Tools Other than Microliths and Retouched Bladelets- Percentages by Site.

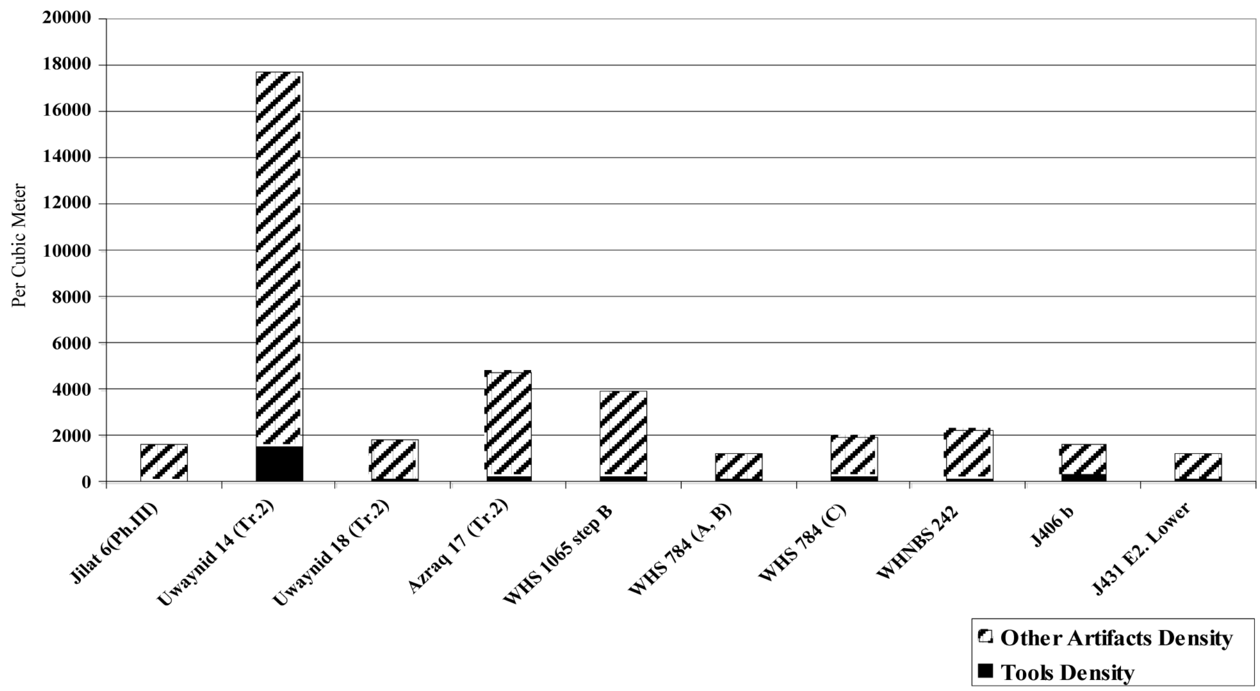

Figure 8: Artifacts and Tools Densities by Sites.

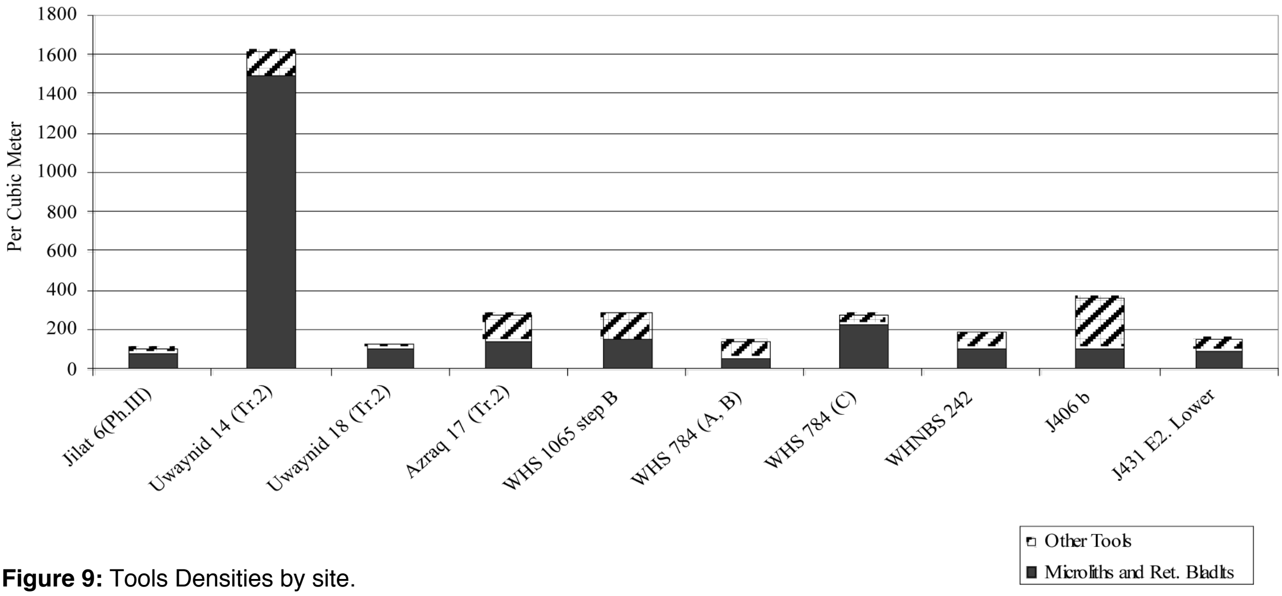

Figure 9: Tools Densities by site.

each other in terms of the manufacturing process (i.e., that they may be the 'same thing') and implies that they might have been functionally interchangeable.

(4) The metrical attribute analysis suggests that Oblique end 1 (backed double oblique truncated or Trapeze) is probably a distinct type and not related to Oblique end 2 (Backed double oblique microburin scar) (Table 4, Figure 10, 11 and 12).On the other hand, the metrical attributes of this type overlap with Combo 1 (backed oblique truncated/backed convex truncated) and Combo 10 (backed oblique truncated/ backed oblique microburin scar). This indicates that Oblique end 1, Combo 1 and Combo 10 are similar in terms of their metrics; it also implies that they are related in terms of manufacturing process, and that they may be functional equivalents.

(5) Although the sample of the Unmodified A-5 (backed oblique microburin scar with unmodified other end or La Mouillah points) is small in size, it is worth remarking that the metrical attributes of this type are very close to those of Oblique ends 1 (backed double oblique truncated or Trapeze). This indicates that these two types might be related in terms of use and manufacturing.

Microlith Fragments. The metrical attributes on microlith fragments are displayed graphically in Figures (13, 14) which give width and thickness statistics as well as counts, means, standard deviations, and range (minimum-maximum). These two Figures provide a better picture of metrical attributes because their sample sizes are much larger than those for complete microliths. In Figures (13, 14) the following points were noticed:

(1) Backed convex truncated, backed with convex microburin scar and backed with oblique microburin scars (La Mouillah Points) overlap metrically. This suggests that these three types are related in terms of both use and manufacturing process.

(2) The La Mouillah point fragments also overlap metrically with the backed obliquely truncated fragment category.

(3) The alternate (Dufour, non-Dufour), inverse (Dufour, non-Dufour) and Ouchtata bladelets overlap metrically. This suggests

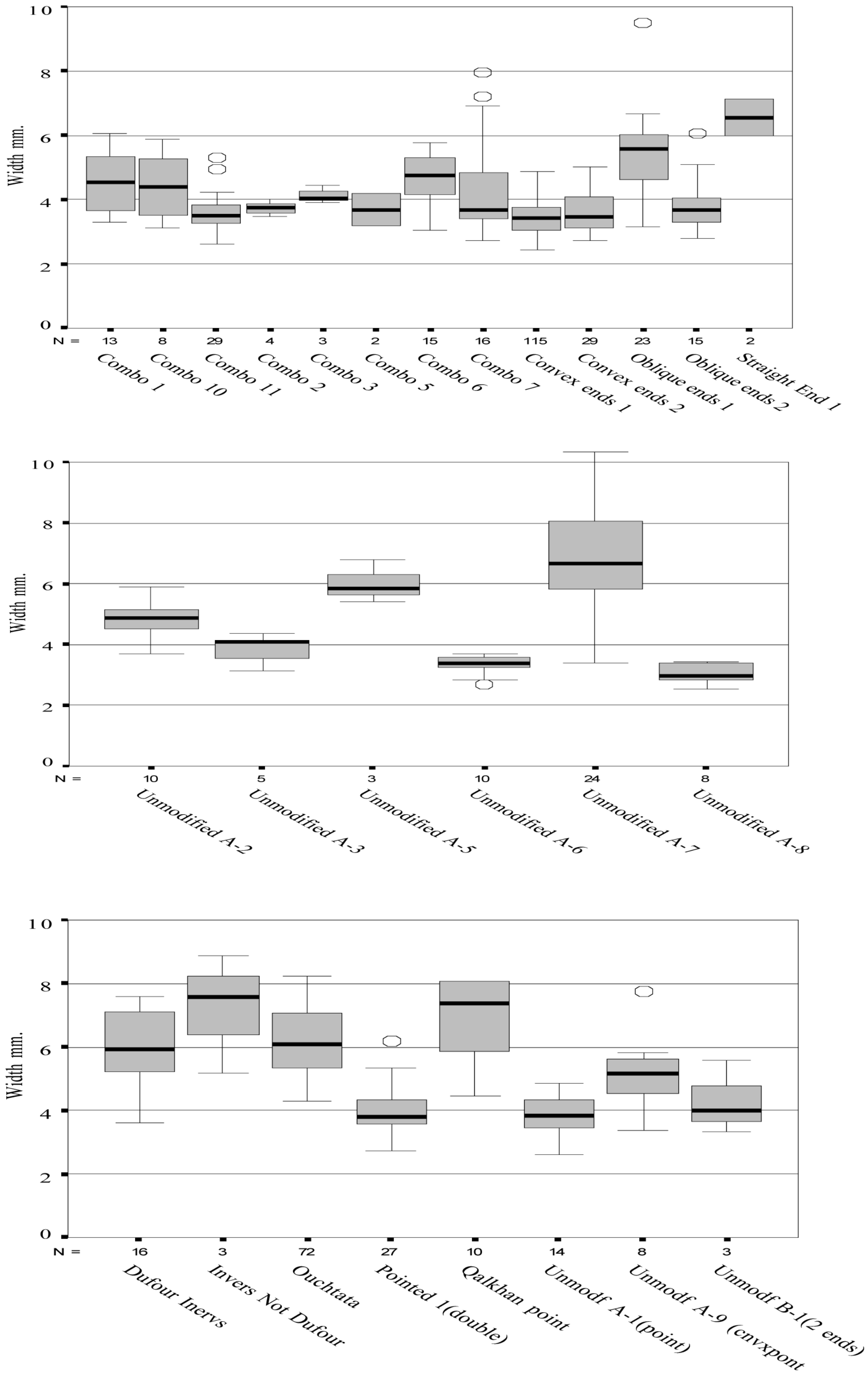

Figure 10: Artifacts and Tools Densities by Sites.

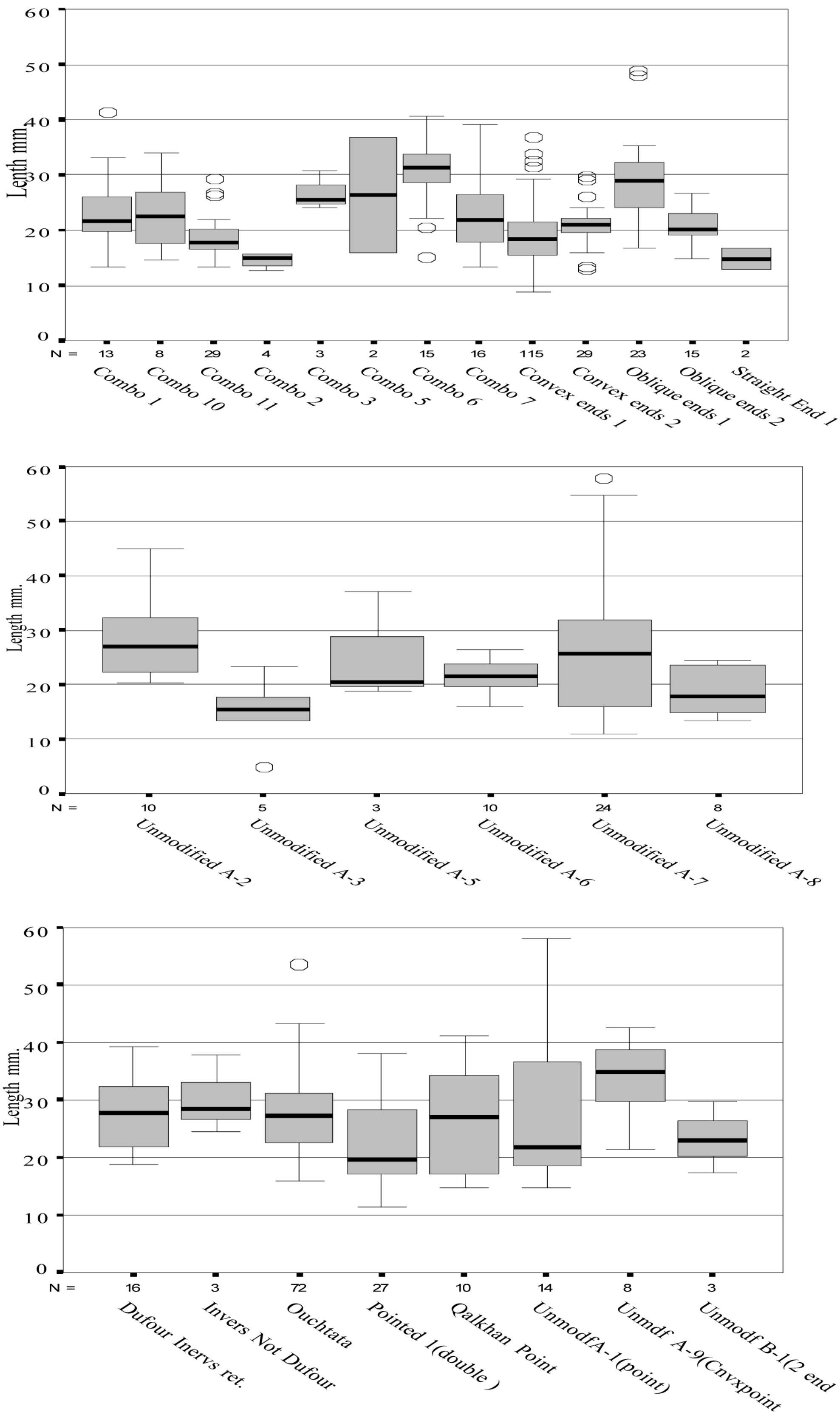

Figure 11: Width- Complete Microliths and Retouched Bladelets.

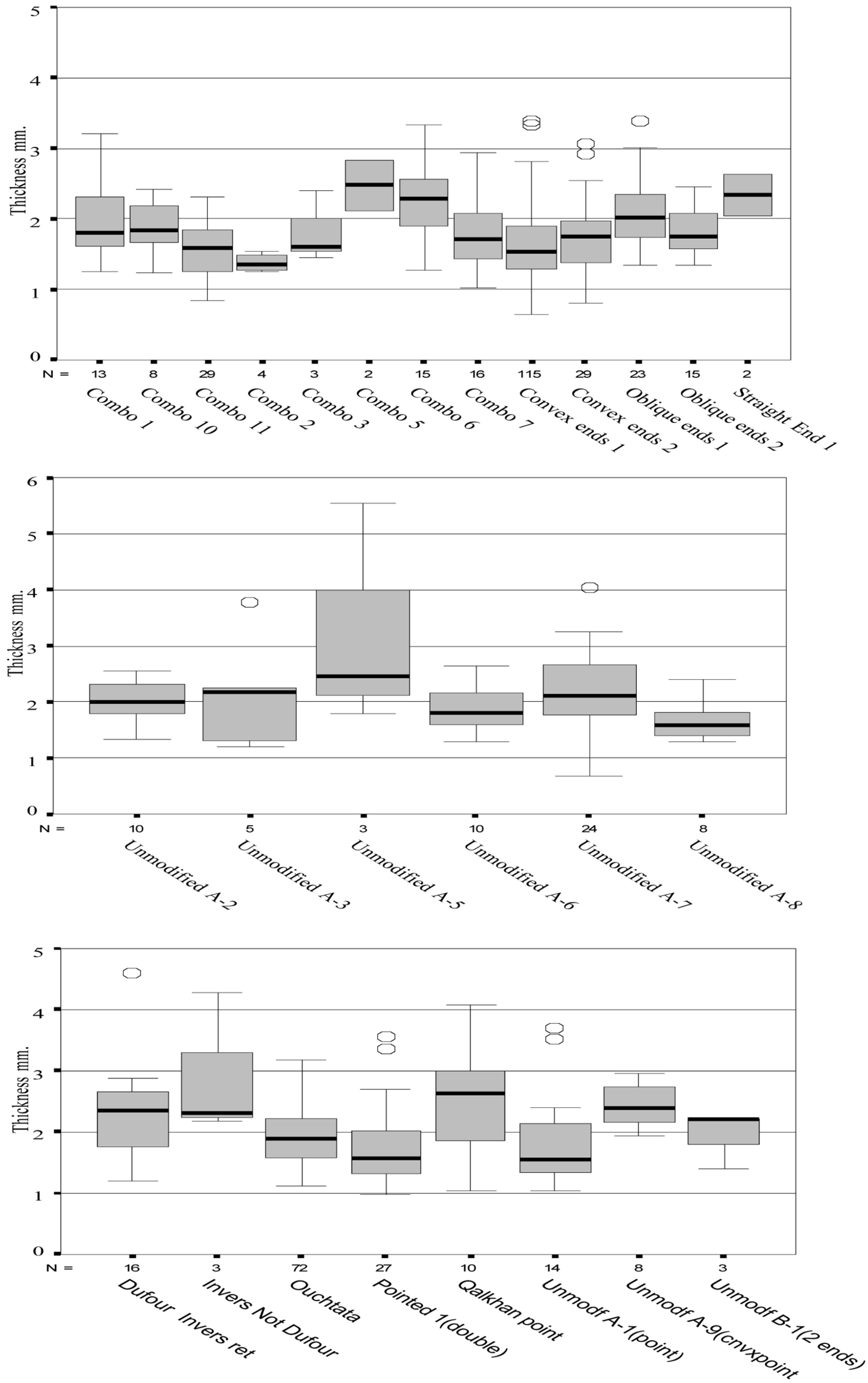

Figure 12: Thickness- Complete Microliths and Retouched Microliths.

		Type name	Description	Count	Length Mean	Length SD	Width Mean	Width SD	Thickness Mean	Thickness SD
Backed Bladelets	I. Oblique Ends	**Oblique ends 1**	Backed Double Oblique Truncation with Unmodified other end (Trapeze)	23	29.19	7.94	5.64	1.84	2.1	0.54
		Oblique ends 2	Backed Double Oblique MB scar	15	20.54	3.52	3.85	0.87	1.81	0.34
	II. Convex Ends	**Convex ends 1**	Backed Double Convex Truncation	115	18.93	4.96	3.45	0.55	1.62	0.48
		Convex ends 2	Backed Double Convex MB scar	29	21.14	4.64	3.66	0.66	1.76	0.51
	III. Straight End	**Straight End 1**	Backed Double Truncation	2	14.81	2.69	6.56	0.83	2.34	0.42
	IV. Pointed	**Pointed 1**	Double Pointed	27	22.17	6.93	4.15	1.21	1.75	0.66
		Pointed/Qalk	Qalkhan Point	10	26.55	9.54	7.71	2.42	2.45	0.9
	V. Combinations	**Combo 1**	Backed Oblique Trunc/ Convex Trunc	13	24.19	7.57	4.58	0.98	1.96	0.55
		Combo 2	Backed Oblique Trunc/ Convex MB scar	4	14.55	1.45	3.74	0.22	1.38	0.14
		Combo 3	Backed Oblique MB scar/ Convex Trunc	3	26.8	3.5	4.14	0.29	1.83	0.51
		Combo 4	Backed Oblique MB scar/ Convex MB Scar	1	40.05		4.61		1.42	
		Combo 5	Backed Oblique MB scar/ Pointed	2	26.29	14.79	3.69	0.71	2.48	0.51
		Combo 6	Backed Oblique Trunc/ Pointed	15	30.16	6.64	4.68	0.82	2.3	0.6
		Combo 7	Backed Convex Trunc/ Pointed	16	22.33	6.65	4.4	1.59	1.92	0.82
		Combo 8	Backed Oblique MB scar/ Convex Point	1	33.81		5.29		2.14	
		Combo 9	Oblique Truncation/ Pointed	1	23.52		3.75		1.57	
		Combo 10	Backed Oblique Trunc/ Convex Trunc0	8	22.87	6.44	4.42	1	1.89	0.38
		Combo 11	Backed Convex Trunc/ Convex MB scar	29	19.43	5.49	3.7	0.82	1.56	0.37
	Unmodified one End	**Unmodified A-1**	Pointed with Unmodified other end	14	28.19	14.53	4.39	1.82	1.87	0.83
		Unmodified A-2	Backed Obliqueliy truncated with Unmodified other end	10	28.62	7.67	4.78	0.65	1.99	0.37
		Unmodified A-3	Backed Convex truncated with Unmodified other end	5	14.89	6.75	3.85	0.5	2.14	1.03
		Unmodified A-4	Backed Straight truncated with Unmodified other end	1	24.87		4.61		1.67	
		Unmodified A-5	Backed Oblique MB scar with Unmodified other end	3	25.39	10.15	6.01	0.7	3.26	2
		Unmodified A-6	Backed Convex MB scar with Unmodified other end	10	21.41	3.23	3.42	0.5	1.88	0.46
		Unmodified A-7	Oblique Truncation with Unmodified other end	24	26.5	12.24	6.83	1.75	2.53	1.43
		Unmodified A-8	Narrow Point with Unmodified other end	8	18.8	4.56	3.05	0.34	1.66	0.36
		Unmodified A-9	Backed Convex Point with Unmodified other end	8	33.89	6.99	5.22	1.27	2.43	0.37
	Unmodified two Ends	**Unmodified B-1**	Backed Bladelet with Unmodified ends	3	23.36	6.15	4.3	1.17	1.94	0.47
Retouched	Bladelets	**Oucht**	Ouchtata Bladelets	72	27.48	6.78	6.25	1.18	1.92	0.43
		Duf Invs	Dufour Inverse Retouchs	16	27.72	6.3	6.1	1.71	2.31	0.81
		InvsNoDu	Invers Retouch Not Dufour	3	30.32	6.81	7.22	1.89	2.92	1.18

Table 4: Complete Microliths-Metrical Attributes

that they are related in terms of use or hafting.

(4) Generally, in Figure (13) it is obvious that the width of most microlith types overlap and that the mean and median widths for most of them fall between 4-6 mm. In addition, it seems that most of the means and medians of microlith thickness fall between 1.5 and 2.5 mm. indicating the range of tolerance for thicknesses, which is related to the width of slots in hafts and armatures of various kinds. The other indication is that all of these types are probably related in terms of manufacturing. Taken together, the evidence suggests that the overall shapes produced have no real influence on the metrical attributes. What mattered most for the foragers who made and used them is what fits the (probably relatively standardized) hafts best.

(5) Width values for the Qalkhan points are quite high and distinct from those of other microliths. The other interesting observation is that the Ouchtata bladelets fall in the same range of metrical attributes as the backed microliths. However, Ouchtata bladelets have higher mean and median widths than the backed microliths. This is because Ouchtata bladelets are finely retouched and the microliths are backed. Backing reduces the width more abruptly than fine retouch.

Chronological and Typological Implication.

The temporal overlap between Late Upper Paleolithic sites and Early Epipaleolithic sites, and both typological and dimensional similarities in the microliths across these periods, suggest continuity between the two units. However, the appearance of both so-called Late Upper Paleolithic and Early Epipaleolithic levels in the same sites (e.g., Tor Sageer WHNBS 242 ,Yutil al-Hasa 784 [C]) raises the question of

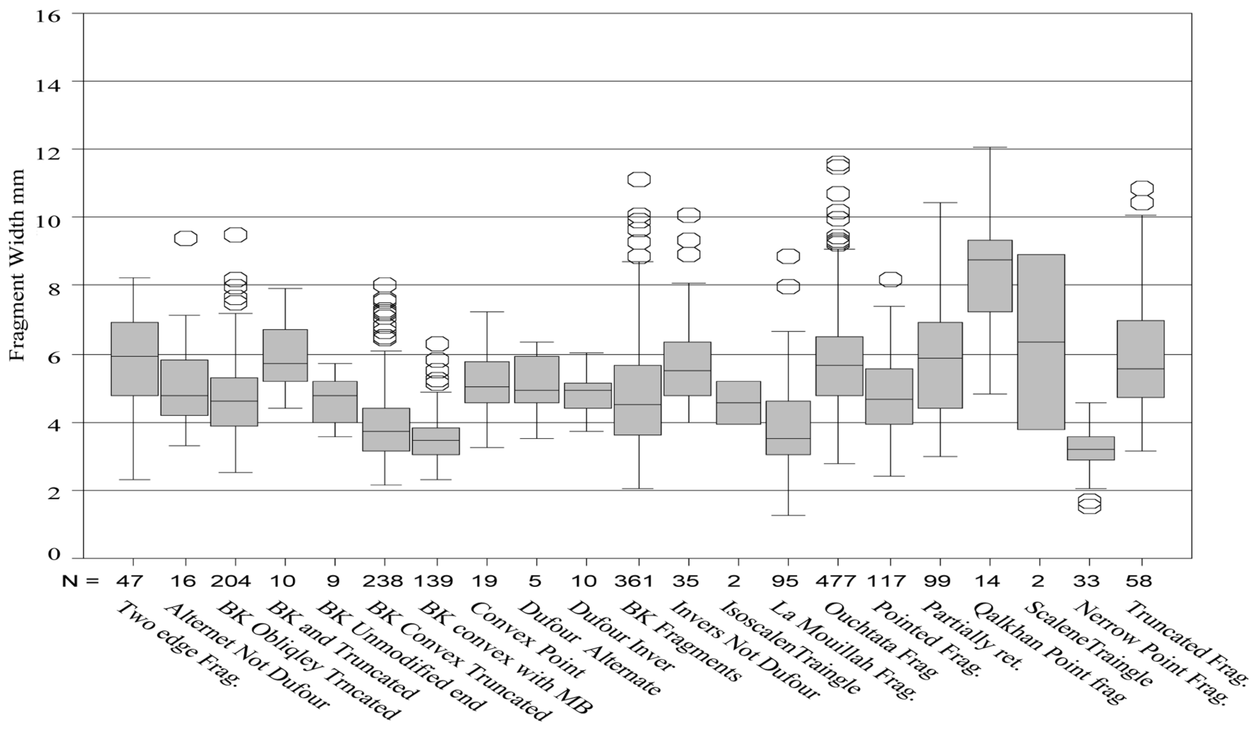

Figure 13: Width- Microliths Fragments.

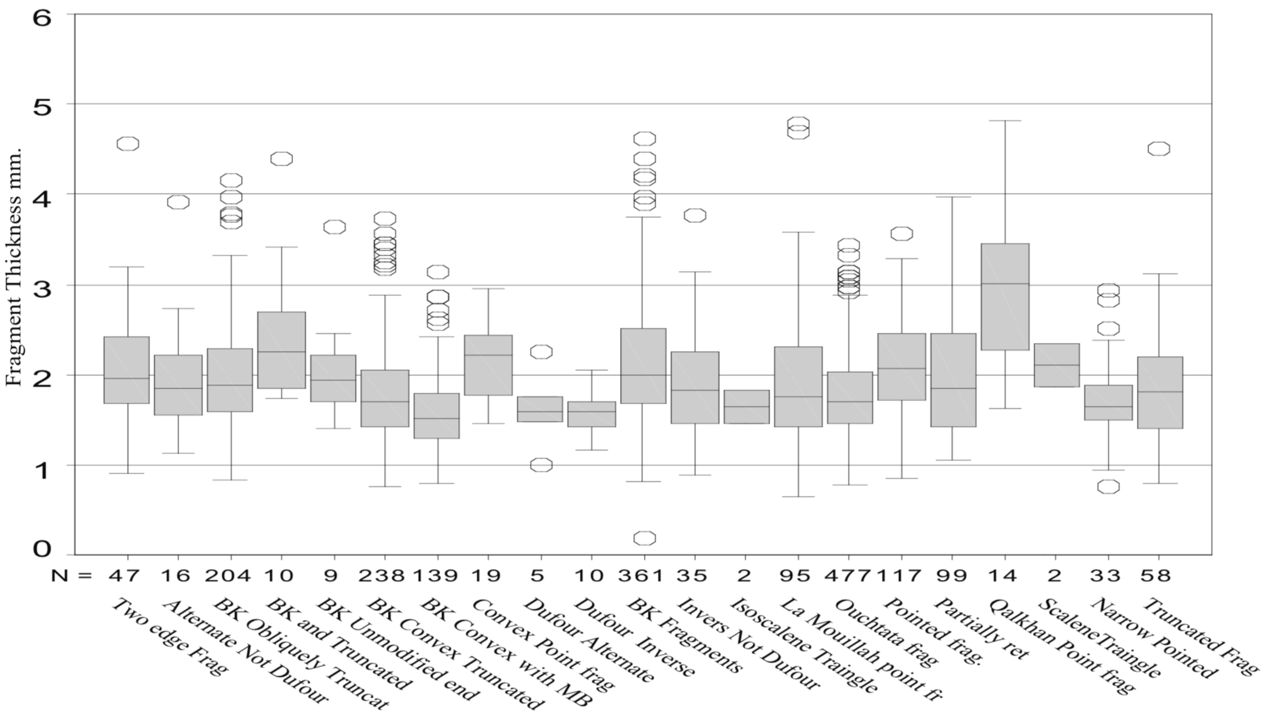

Figure 14: Thickness- Microliths Fragments.

when to draw the line between the two analytical units. Continuity between the Late Upper Paleolithic (identified primarily by Ouchtata bladelets) and the Early Epipaleolithic (backed and truncated microliths) could be explained by frequency shifts in the production of retouched bladelets and by shifts in the locales where they were most often discarded. Similarities in the dimensional characteristics of the microliths cross-cut the transition and argue for continuity. Upper Paleolithic foragers manufactured large numbers of Ouchtata bladelets with fine (and sometimes abrupt) unilateral retouch. During the Epipaleolithic they developed this bladelet technology further by extending the retouch further down the bladelet edge. Since the retouch was more invasive, there was a change from fine to abrupt retouch. Finally, they truncated one or both ends.

Technological change is often a response to changes in the natural environment or in human adaptive strategies (e.g., Kuhn 1995). The appearance of backed bladelet which dominated microlithic assemblages around 22,000 years ago at Tor Sageer and Yutil al-Hasa (C) clearly demonstrates that these widespread and distinctive artifacts had not been confined to the Epipaleolithic. It would seem that backed bladelet dominating microlith technologies had appeared much earlier in the Levant than most workers have realized. This raises the question of the origins of this technology. According to the best currently available knowledge, there were no major environmental changes between 25,000 and 20,000 BP that could have caused foragers to adjust their settlement subsistence systems in radical ways. However, frequency shifts in the activities performed at these sites might account for the change. A definitive answer will come only with use-wear studies of microlithic assemblages that might allow us to identify more precisely the types and ranges of activities performed in these sites.

Interestingly, the analysis in this research also demonstrates that there are no temporally vectored changes in the frequencies of the microlith forms most commonly used as chronological markers distinguishing the Upper Paleolithic and the Epipaleolithic: Ouchtata bladelets, backed microliths, Qalkhan points and microlith points (Figure 15). In Figure (15) it is apparent that Qalkhan points appear continuously throughout the 21-12 kyr BP interval, but always in low frequencies. This suggests that Qalkhan points are not a hallmark or identifier of a Qalkhan assemblage type, and that they cannot be used reliably as archaeological index types. They probably were produced to perform a certain, perhaps relatively circumscribed, function. Similarly, Ouchtata bladelets and backed microliths vary over equivalent ranges, suggesting that both of these types were made and used contemporaneously. This suggests that there is both technological and typological continuity across the 22-15 kyr BP interval of the Upper Paleolithic and Epipaleolithic transition. Furthermore, there are no 'natural' changes in paleoclimate, environment, or resource distribution to distinguish what has been called Late Upper Paleolithic and Early Epipaleolithic. The differences observed among these types are differences in degree (rather than kind), are probably functional in nature, and are manifestly not chronological.

Microlith Technology and its Relationship to Typology

Manufacturing Techniques

Microliths usually are made of bladelet blanks, which were commonly struck from specifically prepared single or multi platform cores. The microburin technique was used to section bladelets to create microburin scars on the microliths. The scar is used to reshape and sharpen the bladelet and to make it suitable to fit the haft. There are three recognized methods of applying the microburin technique (Olszewski n.d.).

The first method involves making one or two notches close to the ends of the bladelet (Figure 16). The notches weaken the bladelet and control the direction of the scar. The bladelet then is struck or snapped from the notch area, an action that creates a scar. This negative is referred to as the microburin scar, and it can be oblique or convex. In the final step of this method, the bladelet is backed, usually with abrupt, backing retouch in order to blunt the edge that fits into the haft, and thus minimize the likelihood of splitting it.

The second method (Figure 17) was introduced to the literature through efforts of describing the manufacturing process of La Mouillah points. This process was first described, but not named, by Barbin (1912). Tixier (1963) later described and named the technique, in the Magreb assemblages from the Maghreb of North Africa. Deborah Olszewski (n.d.) translates Tixier's description:

He described these microlith points as bladelets with an abruptly retouched edge that terminates in a distal or proximal piquant trièdre microburin scar. The use of the microburin technique does not involve creating a notch from which the microburination blow originates. Rather the bladelet is retouched along most of its edge. The point at which the retouch ceases creates a 'shoulder' or pseudo-notch on the piece. It is at this shoulder that the microburination blow is struck (Olszewski n.d.: 6).

This method was used even if only a single microburin scar was required. If the toolmakers decided to make two microburin scars, they would retouch the edge into a concave shape. This would produce two 'shoulders' at which the blow could be struck.

In the course of this research, an important

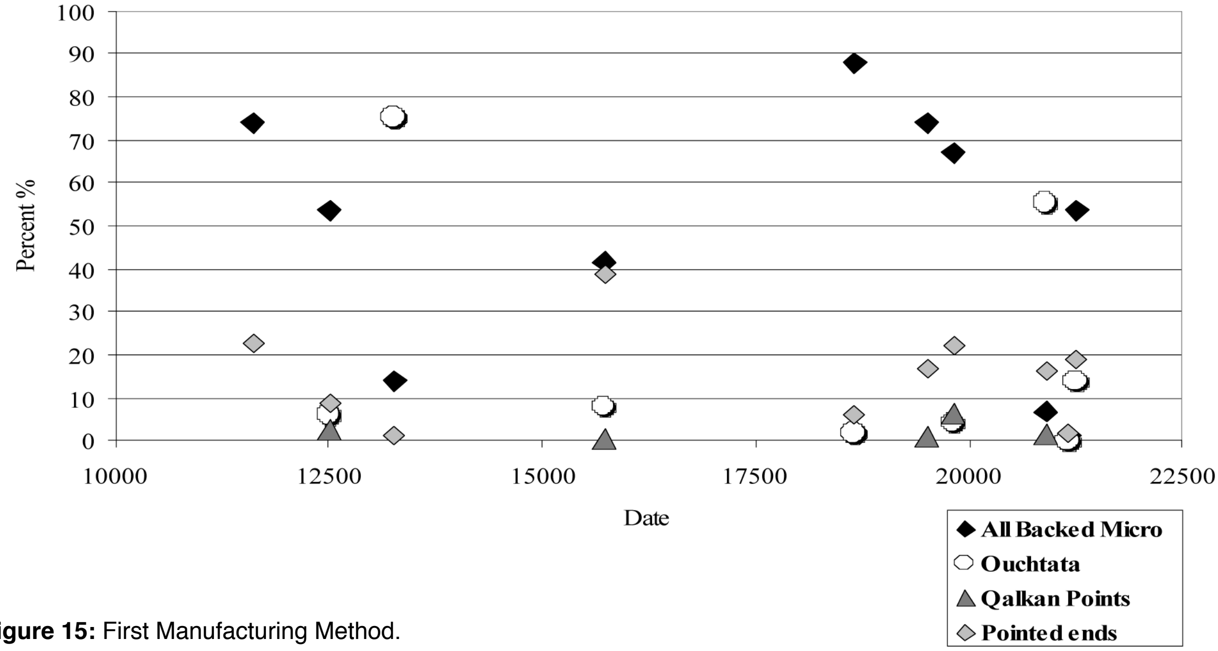

Figure 15: First Manufacturing Method.

difference was observed between microlith assemblages from different sites. In the Wadi al-Hasa sites, the microburin scars were small in size (i.e., short). The bladelets were microburinated, then backed, and the backing included some of the microburin scar. In the Azraq Basin sites (Uwaynid 14 and 18), the bladelet apparently was backed first, then struck, causing a long, sharp scar. This variability in microlith scar shapes between and among sites is probably due to an interesting difference in manufacturing techniques. In the first method, the bladelet is struck and then backed. In the second method, the bladelet is backed and then struck.

The third microburin technique was used to produce Qalkhan points (Figure 18). Donald Henry (1982, 1995) identified these points first in his analysis of the southern Jordan assemblages. The Qalkhan point is a blade or bladelet with a triangular, pointed shape made by using the microburin technique. The first step in shaping the triangle involves heavy retouch on the left lateral edge of the blade/let. Then a notch is made close to the proximal (base) part of the blade/let on the retouched edge. The blade/let is struck at the notch area, which results in a scar. Finally, the scar is retouched or backed, leaving part of the notch obvious. According to Henry (1995), this notch near the base is the distinguishing characteristic of Qalkhan points.

To better understand the suite of behaviors involved in making, using, and discarding the microliths, the typology should be integrated with the manufacturing technique and stages of production. Labeling the types and creating a typology involve recognizing attributes and grouping them. Groups of attributes for Levantine microliths should be matched with the manufacturing stages to distinguish the attributes of final and desired products from the attributes that are part of the manufacturing stages and those that represent incomplete products (Olszewski n.d.). Therefore, it is necessary to explain the technological process of making microliths.

Manufacturing Stages

From the microlith manufacturing process displayed in Figures (16, 17 and 18), it would appear that microliths with a microburin scar (MB) represent an incomplete stage in the manufacture of the desired microlith (e.g., backed oblique with MB scar [La Mouillah points], backed convex with MB scar, etc). However, considering Robin Torrence's (1983) argument that microlithic technologies in general result from time stress, they might have been used as points before they reached their final intended form. Another possibility is that their makers could have achieved their objectives (i.e., came up with artifacts that were 'good enough' to serve a desired end) prior to reaching some predetermined form (a 'satisficer' approach). This could be the case with the Uwaynid 14 and 18 microliths. The microburin scars and the edges of the microliths are very sharp, indicating that they perhaps were used as points even before they were retouched or finished (or were perhaps never used). The assumption is that the broken ends (fragments) were the pieces left in the haft, and were discarded when the hunters returned to camp and exchanged them for new points. However, these fragments could equally well have been broken during the manufacturing process. Interestingly, Figure (5) shows that at all sites except Uwaynid 14 (Trench 1, 2) and Jilat 6 (Phase III), the percentage of backed truncated ends (convex or oblique) is higher than those with microburin scars. This suggests that the groups who lived through the transition between the Upper Paleolithic and Epipaleolithic wanted to produce backed and truncated (convex or/ and oblique) microliths rather than microliths with microburin scars.

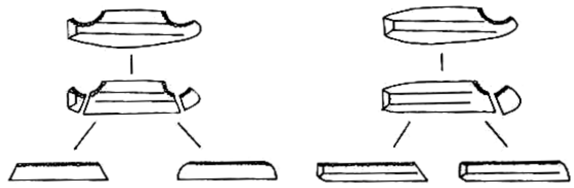

Figure 16: First Manufacturing Method.

Using the first two methods of microburin technique (described above), combined with backing, can produce different groups of attributes and many similar overall shapes of microliths (Figures 19, 20 and 21). This is a good example of the equifinality that is too prominent a feature of chipped stone technologies. Some of the microlith forms, deemed finished products by Old World workers and given distinct type names, may actually represent different stages

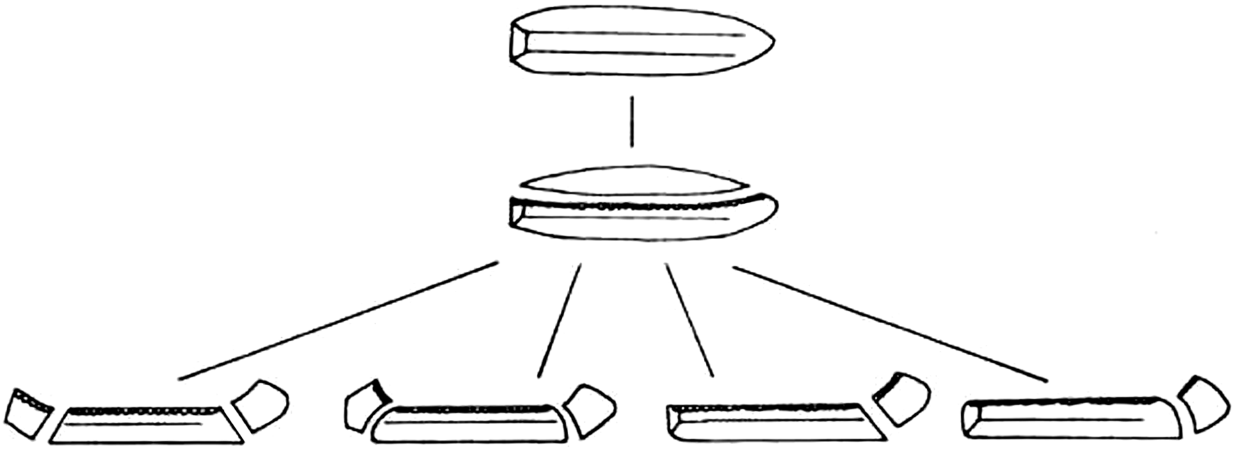

Figure 17: Second Manufactring Method.

of microlith manufacture. La Mouillah points, which were considered Early Epipaleolithic markers for a long time, may well be an example of such a manufacturing stage as is shown in Figure (19) and Table (1), and a fragment with a characteristic backed and an oblique microburin scar would be classified as "La Mouillah point" when it could equally be derived from varieties of other forms that also have backed oblique MB scar ends (e.g., Oblique ends I.2, and Combination V.3, 4, 5, 8, 10). The same applies to the "arched backed microlith" category (a backed bladelet with double convex ends) and the "Trapeze" (a backed double obliquely truncated microlith) fragment ends. The backed convex fragment end could be a broken part of Convex ends I.1, Combination V.1, 3, 7, 11 and Unmodified one end VI.A.3. The backed double obliquely truncated microlith fragment end could be a broken part of Oblique ends I.1, Combination V.1, 2, 6, 10 and Unmodified one end VI.A.2. In summary, if we go through the entire type list and assign each end fragment to a given type, we will end up with numerous possibilities predicated on what the missing end might have looked like. Given that broken microlith are much more common than complete ones, we should be very cautious about assemblages categorized solely on the grounds of microlith forms.

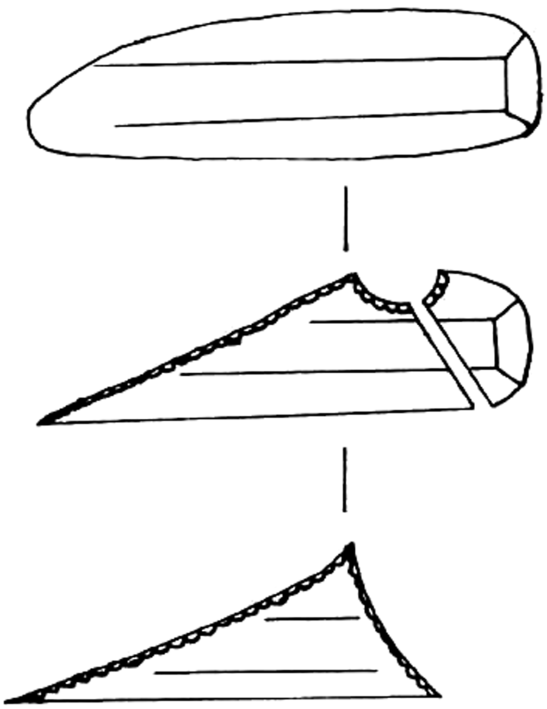

Figure 18: Third Manufacturing Method.

Typology and Manufacturing Stages of Microliths and Retouched Bladelets

The technological methods (Figures 16 and 17) and options described above (Figures 19, 20 and 21) suggest that the different tool types present in Upper Paleolithic and Epipaleolithic sites correspond, in most cases, not to tool types of predetermined form, but rather to different manufacturing stages in a few generalized sequences of microlith production. If this is so, it would underscore the flexibility which is such an important characteristic of the technologies of mobile foragers. For a variety of reasons, manufacturers of the microliths might have chosen to use them before reaching a final, predetermined manufacturing stage. Time stress might have been a factor. The tools might have been usable (the right shape, length; sharp enough, etc. - the satisficer model) prior to the final stage. Alternatively, they might not have fit the hafts had they been backed further. Therefore, it seems appropriate to place each one of the types into a manufacturing stage. The types that correspond to each stage are discussed below (refer to Figures 19, 20 and 21).

Basic Microlith Groups. According to the techniques used, microliths can be divided into three major classes of overall shapes:

(1) Microliths with two modified ends

(2) Microliths with one modified end and one unmodified end

(3) Points.

Table 5: Microliths Stages of Production and the Corresponding Types

Manufacturing Stages and Metrical Analysis

Testing the microlith reduction sequence can provide a more complete understanding of the relationships between and among stages and between the stages and the types in particular. This approach also provides more information regarding use and discard behavior within sites. As suggested by the results of the discriminate analysis, width is the most appropriate metric measurement to use in analyzing stages. The metrical analysis includes both broken and complete pieces. Means, medians and standard deviations of width of the microliths and points were used to test the reduction sequence. Table (5) presents the stages and the types corresponding to each stage. The types referred to in Table (1) sometimes retain the traditional type name to clarify the description (e.g., La Mouillah point, Trapeze, etc.).

I based the selection of types for the metrical tests on four assumptions. First, I assumed that microliths with microburin scars represent the primary manufacturing stage of complete pieces. The pieces representative of this stage are:

(1) For microliths with two modified ends, the corresponding type is complete microliths with double microburin scars.

(2) For microliths with one modified end, and for points, the corresponding type is microliths with one microburin scar.

My next assumption is that the secondary stage for microliths with two modified ends was either microliths requiring more modification to reach the desired tool shape (finished microlith), or microliths that were discarded prior to realisation of the final manufacturing stage because their widths or thicknesses were not suitable for the haft. This stage is represented by complete pieces having a microburin scar at one end and a truncated opposite end.

My third assumption is that microliths which appear finished (final stage) are either pieces that are ready to use and are stored at a site or are pieces that were discarded because they did not fit the haft properly. Microliths belonging to this stage include:

(1) For microliths with two modified ends, the corresponding type is microliths with double truncated ends

(2) For microliths with one unmodified end, or points, the corresponding type is microliths with one truncated or pointed end (the opposite end is unmodified).

My fourth and final assumption states that the broken fragments are tools which people actually used. These fragments appear in the sites because they were exchanged for complete microliths when the hunters returned to the camp. In this case, the broken fragments were used as indicators of what people aimed to produce. The fragments with identified end shapes correspond to this final stage.

Table 6: Microliths and Points Production Stages Width Means, Medians and Standard Deviations.

Results of the Analysis. The results of this analysis are shown in Table (6). For the "microliths with two modified ends" in Table (5), the median and mean width of the primary complete pieces, the secondary complete pieces, and the final complete pieces are all less than 4 mm. The mean and median of the final broken fragments (those people actually used) are also about 4 mm. The ranges of widths for

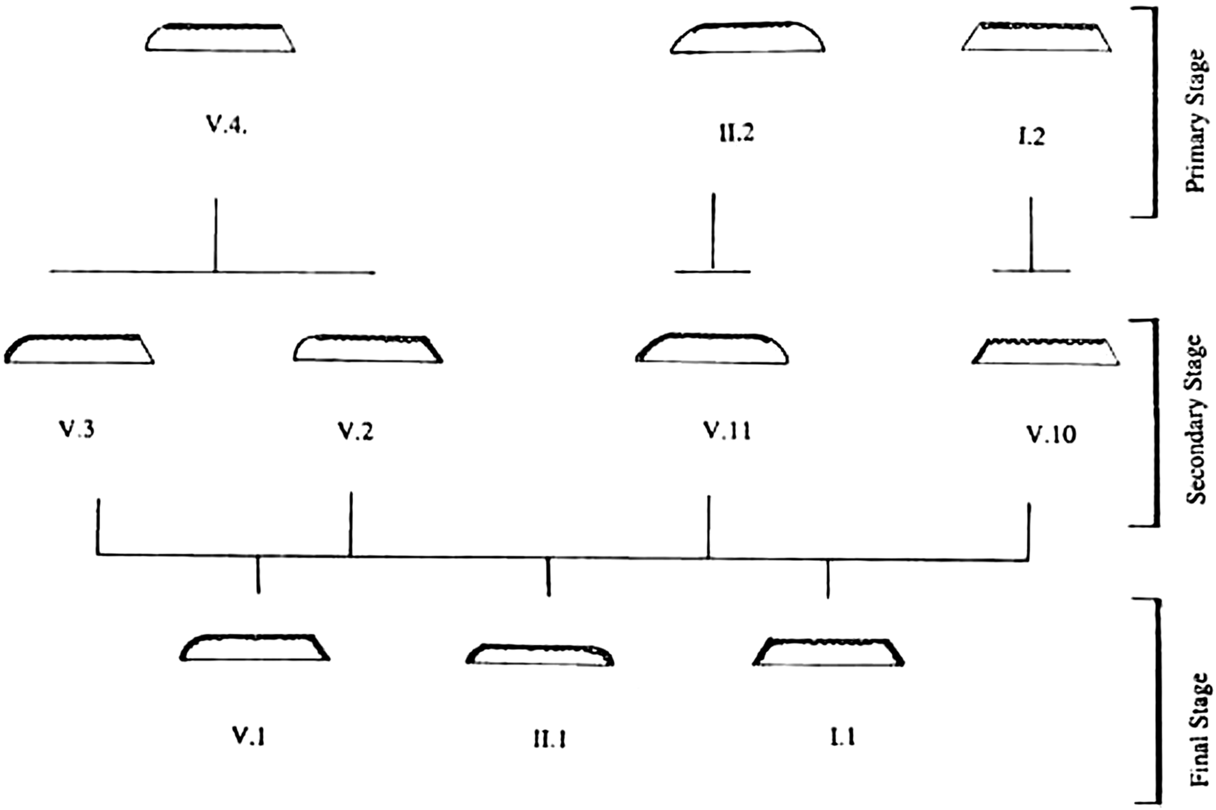

Figure 19: Manufacturing Stages - Two Modified Ends.

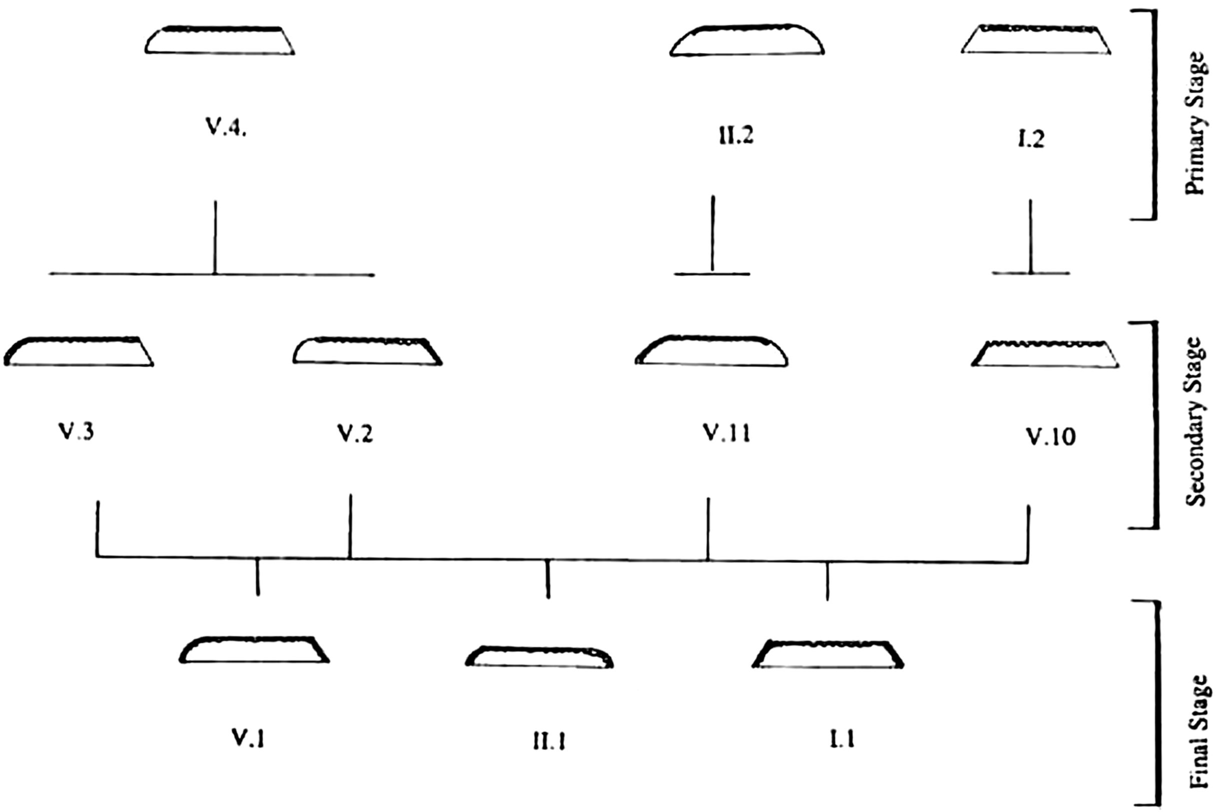

Figure 20: Manufacturing Stages - One Modified End.

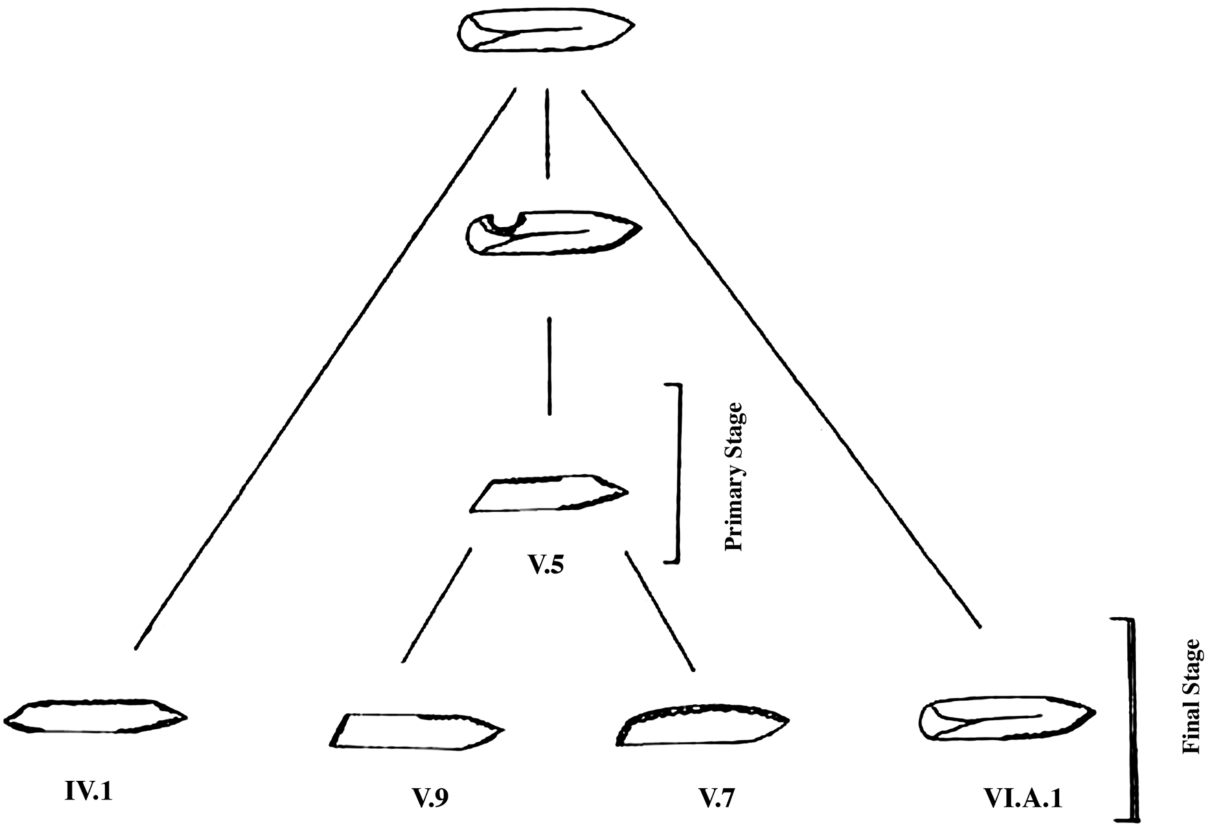

Figure 21: Manufacturing Stages - One Modified End.

each stage overlap each other. This raises two possibilities. Either the complete pieces (whether in the primary, secondary, or final stages) were considered finished and were cached and ready for use, or all the complete pieces recovered from a site were discarded because they did not fit the hafts properly.

To test these possibilities, Figures 10, 13 and 14 show the microliths as types rather than as manufacturing stages. The convex ends can be distinguished clearly from the oblique ends. Interestingly, the backed convex ends (whether truncated or with microburin scars) and the backed with oblique MB scars (whether complete or fragments) have similar median and mean ranges of approximately 3-4 mm. This suggests that they are related to each other as manufacturing stages. In addition, they both probably were cached at the sites to be used at a later time.

Three types are wider than the others (Figure 10). These include:

(1) Complete backed double truncated (Trapeze) (with a median of 5-6 mm)

(2) Complete microliths with one end with Backed and Obliquely truncated (c. 5 mm mean and median)

(3) Complete microliths with oblique microburin scar with unmodified opposite end (La Mouillah Point) c. 6 mm mean and median.

In Table (6), the mean and median widths of the primary stage for broken microliths with one modified end (which includes mostly La Mouillah point fragments) and the primary stage for complete microliths with one modified end (which includes complete La Mouillah points and complete microliths with one end with MB scar) are similar (median about 3.5 mm, mean approximately 4.0 mm). Those considered the final stage for microliths with one modified end have a median width of c. 5mm and a mean width of c. 6 mm. This indicates that primary stage pieces are not related to what was considered the final stage.

When the means and medians of the primary stage (most of which are broken La Mouillah ends) are compared with the means and medians of microliths with two modified ends (Table 6), the results indicate that the broken La Mouillah point fragments are actually broken "microliths with two modified ends." They are not broken fragments of what was traditionally called a La Mouillah point and traditionally described in the typology as a microlith having an oblique microburin scar at one end and an unmodified opposite end.

The preceding is important because many Old World researchers have assumed that broken microliths with an oblique microburin scar were broken La Mouillah points. However, the results of my metrical analysis of the width suggests that these fragments are more likely broken pieces of microliths with two modified ends (see Table [1]: backed double oblique with microburin scar, backed double convex with microburin scar, etc.). This emphasizes that we should be more cautious when assigning broken fragments to a certain type, especially when that type is La Mouillah points.

The primary sample for complete points is unreliable in Table (6) because it consists of only four pieces. However, its width ranges fall into the final stage category. The means and medians of all stages, including the final stage fragments (mostly pointed ends), are around 4 mm. Variation in these points usually occurs at the ends. The recorded widths were measured at the middle of each piece. The middles of points would not be affected at any juncture in the reduction sequence.

Stages of production	No.	Microliths Types
Primary Complete Microliths with Two modified Ends	45	Combo 4, Convex ends 2, Oblique ends 2
Secondary Microliths with Two modified Ends	44	Combo 2, Combo 3, Combo 10, Combo 11
Secondary Microliths Fragment	140	Convex with MB
Final Complete Microliths with Two modified Ends	153	Combo 1, Convex ends 1, Oblique ends 1, Straight End 1
Final Microliths Fragment	452	BK and Obliquely Trunc, BK and Trunc, BK and Convex Trunc.,
Primary Complete with one modified End	13	Unmodified A-5, Unmodified A-6
Primary Microliths with One Modified End Fragment	95	BK Oblique MB scar (La Mouillah) frag.
Final Complete Microliths with one Modified End	51	Unmodified A-2,Unmodified A-3, Unmodified A-4, Unmodified A-7, Unmodified A-9, Unmodified B-1
Final Microliths with one modified End Fragment	85	BK Unmodified end , Truncated end , Convex Point.
Primary Complete Points with Oblique other End	4	Combo 5, Combo 8, Combo 9
Final Complete Points with Oblique other End	31	Combo 6, Combo 7
Final Fragment Points	166	Pointed frag. , Qalkhan Point frag, Unmodified A-8,
Final Complete Points	59	Pointed 1, Qalkhan Point , Unmodified A-1, Unmodified A-8

Table 5: Microliths Stages of Production and the Corresponding Types.

The Distribution of Microlith Manufacturing Stages Across Sites -Observations on Site Function

Classifying the microlith types as production stages allowed me to combine all the "unfinished microliths" (microliths of the primary and secondary stages including complete and fragmentary pieces with microburin scars). I also combined all the "finished microliths" (microliths in the final stage including the backed and truncated [convex and oblique] complete and fragments) and produced a bar graph that shows the distribution of both groups within each site and across all sites.

If the "unfinished microliths" (the microliths with microburin scars including the La Mouillah points) are real types, and their manufacturer considered the types with the microburin scar to be the final stage, then we would expect the frequencies of "finished" and "unfinished" types to be distributed equally at each site and to vary from site to site. However, the results of this analysis indicate that the frequencies of "finished" (final stage) microliths are much higher than the "unfinished microlith" (primary and secondary stages) frequencies at the sites, with the single exception of Uwaynid 14 (Trench 2) which has equal quantities of both. These results demonstrate that the types with microburin scars are, in fact, manufacturing stages. The frequencies of finished microliths (pointed ends and backed truncated ends [convex or oblique]) are high at the sites because they probably represent finished pieces being stored or cached before being used. The "finished" fragments are probably the broken parts that remained in the haft after use, ready to be exchanged for complete microliths. As the case is shown by the classic illustration of David Clarke's (1972) "plug in, pull out" technology, hunters, in the course of refitting their gear, simply pulled out the broken "finished" microliths from the haft and discarded them at the camp.

As noted, "finished" and "unfinished" microliths are approximately equally represented at Uwaynid 14 (Trench 2). The site may well have been a specialized camp with an activity suite that emphasized microlith production. "Unfinished" microliths are also high at Jilat 6 (Phase III), WHS 784 (C), and at J431 E2 (Lower). This suggests that these sites emphasized microlith manufacturing. Interestingly, these four sites are distributed across all three study areas: southern, central, and eastern Jordan. This might be taken as an indication of functional specificity-- these four sites might have manufactured and supplied microliths to other sites. The sites that have smaller amounts of "unfinished" microliths might be hunting stations or camps located near hunting stations or residential bases, where hunters made microliths on an expedient basis as their stocks of replaceable elements ran low.

Ouchtata bladelets and other types of retouched bladelets are not included in this test because they are not part of the microlith manufacturing stages. As stated previously, the "retouch" on these tools probably was caused by cutting meat or other relatively soft material. For this reason the "Ouchtata sites" WHS 618 (H-I), Azraq 17 (Trench 2), and WHS 784 (A, B) are dominated by "finished" microliths. These three sites are possible butchering and processing stations. Successful hunters brought back their game, processed it, and then removed and discarded those microliths broken ("finished") during the butchering process. As a result, we find discarded microlith fragments at these sites along with Ouchtata bladelets.

Some sites seem to have more microlith manufacturing activities than others. The sites that have more microlith ends with microburin scars are probably the sites at which in general

MICROLITHS AND POINTS PRODUCTION STAGES	Count	Width Median	Width Mean	Width SD
Primary Complete Microliths with Two modified Ends	45	3.56	3.75	0.74
Secondary Microliths with Two modified Ends	44	3.70	3.86	0.83
Secondary Microliths (convex MB scar)Frag.	140	3.44	3.57	0.86
Final Complete Microliths with Two modified Ends	153	3.62	3.92	1.24
Final Microliths (BK/ Convex and Oblique Truncated) Frag.	452	4.16	4.41	1.36
Primary Complete with one modified End	13	3.46	4.02	1.25
Primary Microliths with One Modified End Frag. (La Mouillah)	95	3.50	3.90	1.31
Final Complete Microliths with one Modified End	51	5.26	5.69	1.75
Final Microliths with one modified End (Convex Points) Frag.	85	5.51	5.80	1.62
Primary Complete Points with Oblique other End	4	3.97	4.10	0.89
Final Complete Points with Oblique other End	31	4.45	4.53	1.26
Final Frag. Points	166	4.53	4.85	1.90
Final Complete Points	59	3.83	4.66	2.10

Table 6: Microliths and Points Production Stages Width Means, Medians and Standard Deviations .

more microlith manufacturing was carried out. These sites are Uwaynid 14 (Trench 2), Jilat 6 (Phase III) WHS 784 (C) and J431 E2. The sites that include more backed and truncated ends (convex or oblique) are probably the sites at which hunting activities were more important than microlith manufacturing. These sites include WHS 1065, Uwaynid 18 (Trench 2) and WHNBS.

Results and Discussion
Typology and Technology

The Old World paradigm developed by the late François Bordes (1961) suggests that the morphology of the stone tools is discrete, predetermined, and corresponds to the mental templates of the people who lived in prehistory. In addition, it suggests that these morphologies convey meaning related to social identities. In general, this traditional paradigm concentrated on the form of the discarded end products of the "life histories" of tools and neglected the manufacturing, maintenance, and discard processes themselves. However problematic it might appear from the current Anglophone perspective on lithic technology, the Bordesian paradigm was adopted wholesale by Levantine prehistorians in the early 1970s, and remained the dominant view of change in paleolithic stone tool assemblages, and what caused change to occur.

There are, however, alternatives to Bordes' predetermined morphology of retouched stone tool types. Most of these alternatives originate with archaeologists trained in Britain or the United States, who have intellectual traditions distinct from those of Latin Europe. In this summation, I will refer to three of these alternatives that justify why I undertook to pursue this project in the way I did.

The functional paradigm advocated by Lewis Binford (1973, 1977, 1979) argues that modal variability in stone artifact assemblages is due to functional differences-- differences in the kinds of activities in which prehistoric foragers routinely engaged. Binford suggested two polar kinds of technological organization, which in actuality ranged along a continuum from curated tools to expedient tools.

One method of organizing technology relied on curation and included the production of tools that were useful for a variety of tasks, in a variety of contexts. Tools thought to have been made in anticipation of their use were retained (curated) through a number of uses, transported from one place to another, and then recycled when they no longer served their original purpose. The second method of organizing technology relied on expedient tools that were casually made when needed for specific tasks, then used to complete those tasks, and finally discarded.

In the research presented here, microliths correspond most closely to the concept of expedient tools that were made to serve a range of tasks and were subsequently discarded. Replaceable elements in compound tools, they are the quintessential "plug in, pull out" technology, to use the words of David Clarke (1973). Other tool types like end and sidescrapers, burins and, arguably, notch/denticulates, resemble more the concept of curated tools. However, it should also be kept in mind that microliths (or the bladelets on which they were made) were manufactured in anticipation of future needs (an aspect of Binford's definition of curation). Those that were curated in microlithic technological systems were the labour-intensive hafts, armatures, and shafts, made from wood, bone or antler. Of those, the microliths are the only surviving traces.

Arthur Jelinek (1976) has argued that raw material quality imposes a range of constraints on the techniques used to produce stone tools. Raw material quality may require using certain techniques which, in turn, tend to produce certain morphological "types". Again, raw material package size and shape probably influence the size and shape of the final tool form. This idea has been carried forward, and developed further, by Steve Kuhn (e.g., 1995), especially as regards how forager mobility affects decisions about the kinds of gear hunters carry with them.

Douglas Bamforth (1986) argues that recycling tools actually requires more time and energy than simply making new tools. There is only a need for recycling and maintenance when there is a scarcity of suitable raw material. Quantities of high quality raw material seem to be widely available near all the study sites (and in the southern Levant generally), suggesting that it is highly unlikely that microliths were recycled or reshaped to any significant degree. In addition, some (complete) Epipaleolithic microliths are so small that modifying them in any way would have proved difficult, if not impossible.

Differences and Similarities. For early Epipaleolithic microliths in the Levant, researchers have tended to emphasize attribute differences rather than similarities. Moreover, they tend to explain pattern in attribute differences by invoking the different styles held in common (as a consequence of social learning) by distinct cultural entities of some kind. My research emphasizes attribute similarities. Results of the morphological analysis presented here indicate that there is a great deal of attribute similarity between what are usually considered to be different (and discrete) types. The metrical analysis of microlith types suggests that length has no direct effect on the form or function of microliths. Thickness is fairly standardized for all types.

Equifinality in Production and Reduction Sequences. In his model for Middle Paleolithic scrapers, Harold Dibble (1984, 1995) proposed that their morphological attributes were caused by transformation of blanks of particular modal dimensions during a generalizable sequence of use and resharpening. He argued that the morphological distinctions amongst Bordes' 27 sidescraper types have little to do with the mental templates of Mousterian foragers; they rather correspond to stages in the reduction and resharpening process, and not to functional or stylistic differences amongst discrete types.

In this research, the morphological and the metrical attributes of microlith types strongly suggest that these types correspond to manufacturing stages (Figures 19, 20 and 21). Prior to final shaping, the microburin technique was used resulting in microburin scars on backed microliths (Figures 16, 17, and 18). All stages, other than those involved in making a point, include backed microliths.

The primary stage in microlith manufacture produces forms or types that have two microburin scars on microliths with two modified ends, or one microburin scar on microliths with an unmodified end. The secondary stage for microliths with two modified ends includes types that have a microburin scar at one end opposite a truncated end (which can be either convex, oblique or straight). There is no secondary stage for types with one modified end and an opposite unmodified end. The final stage (finished microliths) for microliths with two modified ends corresponds to the types that have two truncated ends (either convex, oblique or straight) or that have double points. The final stage for types that have one modified end opposite an unmodified end corresponds to the types for truncated microliths (convex, oblique or straight) or for pointed with retouch. In my analysis, the truncated (convex, oblique or straight) end fragments were considered finished microliths and were added to the final stage. The fragments with a convex microburin scar were added to the secondary stage of the two modified ends. The fragments with an oblique microburin scar (assumed to be broken La Mouillah points) were added to the primary stage of the microliths with one modified end.

The excavators' descriptions of microlith assemblages matched the extremely large number of microlith fragments found in the sites under study. This indicates that each fragment was assigned to a certain type without actually knowing what the other end might have looked like (i.e., they guessed). The researchers assumed that each of these fragments belonged to a specific type in the typology. This research demonstrates that there are too many alternative possibilities for what the other end might have looked like for such conjectures to have meaning or credibility. It is unjustifiable to assign microlith fragments to assumed overall shapes or types. Consider, for example, the La Mouillah points. The broken end of a La Mouillah point could be assigned to any of the following types: Backed Double Oblique with microburin scar, or Backed Oblique with microburin scar/Backed Convex Truncated, or Backed Oblique with microburin scar/Backed Convex with microburin scar, or Backed Oblique with microburin scar with Unmodified end (the last is the traditional shape of a complete La Mouillah point). It is also demonstrated metrically that La Mouillah point fragments are more likely to be broken parts of the following types : Backed Double Oblique with microburin scar, or Backed Oblique with microburin scar/Backed Convex Truncated, or Backed Oblique with microburin scar/Backed Convex with microburin scar, which is not the traditional shape of a complete La Mouillah point.

Implications for Mobility: The artifact types found in archaeological sites can be used to help predict the relative degree of mobility of their manufacturers (e.g., Kuhn 1995). Mobility puts constraints on the number and kinds of tools that can be carried. Consequently, in situations involving uncertainty, and where ready supplies of suitable raw materials might not be available, tools should be designed for increased portability. In order to do this, highly mobile groups design tools that are less specialized and more multipurpose in character. An argument has been made that such tools also tend to be smaller and lighter (Shott 1986; Torrence 1983; Ebert 1979; Keeley 1982). However, decreasing the number of tools being carried need not mean less technological diversity if foragers can modify suitable interchangeable blanks "on the spot" as unforeseen contingencies arise (Shott 1986).

From the artifacts found in the sites under study, it seems that highly mobile groups lived during the transition period ranging from the Upper Paleolithic to the Epipaleolithic in this part of the Levant. Most tools types found were multipurpose in nature, and corresponded to expectations about the kinds of tool kits required of highly mobile foragers. A convergence of other lines of evidence not investigated here (e.g., and esp. site characteristics) also supports the conclusion of high mobility (Marks and Freidel 1977).

The composition of lithic assemblages within the sites can be used to help predict site function and degree of mobility in the settlement-subsistence systems of which those sites were once a part. If technological diversity correlates strongly with resource availability and the range of tasks performed, as proposed by Shott (1986), the lithic assemblages could offer a better understanding of subsistence-settlement organization.

Site Types: Jelinek (1976) recognized three site types based on artifact composition: (1) Manufacturing sites. According to Jelinek, these include high proportions of exhausted, unusable, and partially worked cores, broken or irregular (misstruck) flakes, and large amounts of debris resulting from core reduction and subsequent manufacturing processes. (2) Use sites. These sites contain only the various end-stage products of manufacturing. They have little or no manufacturing debris, exhausted cores or broken tools. (3) Use and manufacturing sites. In Jelinek's classification of site types, these include large numbers of complete and broken tools combined with manufacturing debris indicating a wide range of activities (i.e., they have high diversity indices).

Lithic Assemblage Modalities: The cluster analysis of the artifact composition of the study sites indicates that there are three kinds of sites in the study area: (1) sites in which bladelet and flake blanks are present in almost equal proportions; (2) sites in which flake blanks are more common than bladelets; and (3) sites in which bladelet blanks are more common than flakes. Interestingly, the sites in which bladelets predominate are the same sites that have more microliths than other tool types. These sites also have high percentages of microburins. The sites under study are divided functionally according to their lithic assemblages into four classes that reflect the predominant activities conducted in each class. The four site classes are (1) meat processing and butchering sites, (2) sites in which the manufacture of hunting gear was important, (3) sites in which microlith production was emphasized, and (4) multipurpose residential bases.

As a general remark, based on the previous analysis, it seems that the sites that have flake dominated assemblages also have large numbers of macrolithic tools. I attribute this to the necessity for having large flake blanks used to manufacture large end and sidescrapers, notches, denticulates, burins, etc., which can be repeatedly rejuvenated or resharpened. At these sites, Ouchtata bladelets are found along with the microliths. The lithic composition of these sites indicates that the groups occupying them practiced hunting, tool maintenance and meat processing.

The contrary relationship also holds true. The sites that have more blade/lets than flakes are the same sites that have more microlithic than macrolithic tools. The groups occupying these sites concentrated more on hunting and manufacturing microliths. They relied heavily on the microburin technique, and probably produced large numbers of microliths (or bladelets) which they carried around with them in anticipation of future needs (esp. refitting weapons and tools in the field).

The sites that have equal proportions of flakes and bladelets have both macrolithic tools and Ouchtata bladelets. The groups who occupied these sites concentrated more on meat processing and scraping activities. In these sites, it seems that bladelet blanks are also used as tools.

Sites emphasizing hunting and the manufacturing of hunting gear are represented by Jilat 6 (phase III), Uwaynid 18 (Trench 2), WHS 784 (C), and J431 E2 (Lower). Artifact densities in these sites vary from moderate to low. This probably indicates that they were occupied for relatively short periods of time. There was a much higher production of bladelet blanks than flakes at Jilat 6 (phase III), Uwaynid 18 (Trench 2), WHS 784 (C), J431 E2 (Lower). These sites also have large numbers of microliths and microburins, and low numbers of other tool types. The indication is that these were hunting sites with an emphasis on microlith production.

Microlith manufacturing sites are represented by Uwaynid 14 (Trench 2), which has an extremely high artifact density. Occupational zones at the site separated by thick sterile strata suggest that Uwaynid 14 (Trench 2) is a multi-occupational site. The site included very high ratios of bladelet blanks, backed microliths and microburins. All microlith types are represented in the assemblage at Uwaynid 14 (Trench 2), including equal amounts of "finished" and "unfinished" microliths. The site has very high counts of other tool types. The flake/blade/let ratio of the assemblage at Uwaynid 14 (Trench 2) indicates that it probably was a microlith manufacturing site.

Meat processing and butchering sites are represented by Azraq 17 (Trench 2), WHS 618 (H-I) and 784 (A, B). Although the artifact density of WHS 618 (H-I) could not be estimated in this research, the large numbers of artifacts recovered from its shallow units indicated that density at this site would have been quite high. The original surface collection and tests in 1984 at WHS 618 yielded 26,809 artifacts from two small, shallow exposures on the fossil spring eye (Tests H, I). Estimates of the number of artifacts on the surface, which was collected using a systematic, randomized sampling design amounting to 3.3% of the site surface area (c. 12,000 m2), generated a figure of nearly 300,000 (290,424 actually) (Clark et al. 1988: 235-242). As noted above, the density of Azraq 17 (Trench 2) was also very high.

Observations on Chronology and Typology:

For the past 50 years, the division between the Late Upper Paleolithic and Early Epipaleolithic has depended on perceptions of lithic typological variation (Byrd 1994). Gilead (1991) suggested that we lump together the end of the Late Upper Paleolithic and beginning of the Early Epipaleolithic, along with the intervening transition interval, and treat it all as one period. The research reported in this study lends considerable support to this suggestion. Although backed microliths have long been considered temporal markers for the Epipaleolithic (just as Ouchtata bladelets were thought to mark the Late Upper Paleolithic), my research shows that backed microliths and Ouchtata bladelets both occur in variable but equivalent frequencies through out this interval (c. 22-15 kyr BP) and are often found at the same sites (Figure 15). That their ratios differ from one site to another is almost certainly due to site function (i.e., the mix of activities habitually carried out by the site's occupants) rather than to change over time.

Conclusion

In the Levant, as in many regions of the circum-Mediterranean Old World, the Upper Paleolithic-Epipaleolithic transition, at about 20,000 years ago, is identified by an implicit consensus based wholly on typological systematics. That is, certain retouched stone tool types are considered to be time-sensitive "diagnostics" of the Upper and Epipaleolithic, respectively. Moreover, divisions within the Upper and Epipaleolithic are also based on supposedly time-sensitive, stylistic typological markers. It has been the objective of this research to try to assess whether there are any meaningful behavioural differences between assemblages labeled by convention as "late Upper Paleolithic" and those labeled "early Epipaleolithic". It has been my contention that these systematics are often used uncritically, and without any demonstrable relationship to a problem or a hypothesis.

The typological systematics used in the Levant were derived from the Old World paradigm developed by François Bordes. The Old World paradigm suggests that the morphology of stone tools is discrete and predetermined, and that it corresponds to mental templates of the people who lived in the past. Moreover, and equally problematic, pattern in morphology is taken to convey meaning related to social identity. The paradigm concentrates on the form of the discrete end products of lithic reduction strategies and neglects the manufacturing, maintenance and discard processes which occur prior to the incorporation of a stone artifact in a geological context.

American workers have developed alternative interpretations of pattern in stone artifact assemblages. Two widely-invoked alternative paradigms developed by New World workers are: (1) a functional paradigm, first suggested by Lewis Binford, emphasizing that variations in stone tool morphologies and frequencies are related to tool functions and activities conducted on sites, and (2) an approach advanced recently by Michael Barton and Michael Neeley that also de-emphasized typology, stressing the material correlates of human behavior, and concentrating on general situational variables with which all all mobile foragers must come to grips (see also Kuhn 1995).

For the past 50 years, the division between the Late Upper Paleolithic and Early Epipaleolithic has depended on perceptions of lithic typological variation. In recent (post-1987) formulations, backed microliths were considered temporal markers for the Epipaleolithic in general, whereas Ouchtata bladelets were thought to mark the Late Upper Paleolithic Ahmarian.

This research examined lithic assemblages that date to the 22-17 kyr BP interval collected from Jordanian sites (Azraq 17, Uwaynid 14, Uwaynid 18, Jilat 6, WHS 784, WHS 618, WHNBS 242, J406, and J431). The analysis suggested that behavioral patterns in lithic technology, typology, raw material procurement, subsistence, and site distribution, especially as the latter relates to mobility, were the primary determinants of inter-assemblage variation over the transition interval.

For microlithic-dominated early Epipaleolithic Levantine assemblages, researchers have tended to emphasize attribute differences rather than similarities. Moreover, they tend to explain pattern in attribute differences by attributing the different styles to learning in a social context (and thus representative of distinct cultural entities of some kind). This research focused instead on attribute similarities. Results of the morphological analysis presented here indicate that there is a great deal of attribute similarity between what are usually considered to be different (and discrete) microlith types.

In this research the following methods were used: (1) tabular data display, (2) multivariate pattern searches based on relative frequencies (percentage tables, density tables, metrical attributes), (3) hierarchical cluster analysis, and (4) discriminant function analysis.

The metrical analysis demonstrates that (1) width is the most highly standardized, hence meaningful, metric attribute; (2) width for "backed double convex truncated" microliths is strictly standardized; (3) the trapeze ("backed double oblique truncated" microlith is probably a distinct type; (4) La Mouillah point fragments are more likely broken parts of microliths with two modified ends, rather than being a discrete tool type, and (5) metrical attribute analysis of the microliths indicates that most types are related to each other in terms of stages in a generalized manufacturing sequence.

The sites studied were divided functionally according to their lithic assemblages into four classes that reflected the predominant activities conducted in each class. The four site classes were (1) meat processing and butchering sites, (2) sites in which the manufacture of hunting gear was important, (3) sites in which microlith production was emphasized, and (4) multipurpose residential bases.

Pattern in microlith morphology and metrical attributes strongly suggests that the conventionally-defined microlith types correspond to manufacturing stages interrupted, in most cases, prior to final shaping and/or that they are the discarded remnants of a few general size and shape categories. The research also showed that backed microliths and Ouchtata bladelets occur simultaneously over a 7,000 year-long interval (c. 22-15 kyr BP) and at the same sites. That their frequencies differ from one site to another is probably due to site function. They cannot be used as time-sensitive markers of the Epipaleolithic and the Upper Paleolithic, respectively.

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ملخص: في النصف الأخيرمن القرن الماضي، عُدّت الشفرات المظهرة علامة من علامات المرحلة الانتقالية؛ بينما عُدّت الشفرات الاشتادية علامة من علامات مرحلة العصر الحجري القديم الأعلى المتأخر . هذا البحث عُنِيَ بدارسة الادوات الصوانية، في ثلاثة عشر موقعا في الأردن . وقد استخلصت نتائج هذا البحث، من دراسات صناعة الأدوات الصوانية ، وتصنيفها، ودراسة مصادر الموارد الغذائية، والمواد الخام، ودراسة توزيع المواقع الأثرية حيث ارتبطت الأخيرة بتنقل الانسان في تلك المراحل . من خلال الدراسة، تبين أن اختلاف أشكال الشفرات المظهرة وقياساتها، يعود الى أن كل شكل منها مرتبط بمرحلة من مراحل التصنيع. كما أن الدراسة بينت، أن الشفرات المظهرة والشفرات الاشتادية ظهرت في الفترة الزمنية نفسها وفي المواقع نفسها؛ ما يؤكد أن تنوّع أشكال هذه الشفرات وتوزيعها يعود إلى وظيفة الموقع، وليس إلى اختلاف المرحلة التي ظهرت بها.

Notes

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