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Lithic Technology and Settlement Pattern Variability within the Levantine Mousterian: A Comparison of Sites WHS 621 and WHS 634 from Wādī al-Ḥasā

Introduction: The Model

In their long term studies of Middle and Upper Palaeolithic settlement patterns in the central Naqab highlands, Marks and Freidel (1977) have recognized two distinctive patterns. The first, associated with the Early Mousterian (>90,000-45,000 years BP), consists of relatively "permanent" residential base camps near reliable water sources surrounded by a series of ephemerally occupied quarry, hunting, and foraging "limited activity" satellites. This has been called a "radiating" pattern of exploitation and is similar to what Binford (1980) has called a "logistical strategy". This radiating pattern is argued to be an adaptation of mesic climatic conditions. The second pattern, associated with the Upper and early Epipalaeolithic (45,000-16,000 years BP), consists of a "circulating" pattern of smaller, essentially similar, multi-purpose camps established throughout a foraging range (Marks and Freidel 1977: 150; cf. Binford's [1980] notion of "forager"). Site distribution studies indicate that Upper Palaeolithic groups were habitually exploiting larger territories than their Middle Palaeolithic predecessors (Marks 1987: 5). Upper Palaeolithic sites appear to be functional and morphological replicates of one another (i.e., no base camp/satellite distinctions are evident).

In general, then, Marks and Freidel (1977) see an increase in residential mobility coinciding with long term climatic desiccation from mesic/Mediterranean to xeric Irano/Turanian steppe vegetation during the Middle to Upper Palaeolithic in the southern Levant. Palaeoenvironmental data from an-Naqab suggest that the Early Middle Palaeolithic environment was considerably wetter than today, with climatic belts distributed 200-250 km south of their present locations. Limited evidence from the later Middle Palaeolithic from both an-Naqab and south Jordan indicate increased aridity during this period. This trend seems to have continued up through the Middle to Upper Palaeolithic transition (c. 40 kyr BP) and into the Upper Palaeolithic (Clark *et al.* 1987: 215).

Although to some it might not be reasonable to suppose that Mousterian foragers (i.e., archaic *Homo sapiens*) behaved like ethnographically-known "logistical collectors" during the early phases of the Middle Palaeolithic (Clark 1984), it is reasonable to look at relative degrees of mobility across a long temporal span (from approximately 120-50 kyr), for a major climatic trend of this duration and magnitude would almost certainly have had some effect on settlement mobility, and upon raw material procurement, over time. This study compared two Middle Palaeolithic sites, one relatively early — WHS 634 ('Ayn Difla), and one relatively late, WHS 621, from the Wādī al-Ḥasā region in west-central Jordan. It was expected that the assemblage from the later site would demonstrate greater signs of curation (*sensu* Binford 1979), a technological hallmark of increased residential mobility, relative to the earlier site (Bamforth 1986; Parry and Kelly 1986). The earlier Middle Palaeolithic site, in contrast, was expected to exhibit a more "expedient" lithic technology in response to its proposed greater occupational stability (Bamforth 1986; Chatters 1987; Parry and Kelly 1986).

The Middle Palaeolithic in Wādī al-Ḥasā

Wādī al-Ḥasā is located in west-central Jordan, some 100-120 km east and slightly north of the central Naqab highlands. This major wadi system, which was, in the Upper Pleistocene, characterized by a series of shallow alkaline lakes flanked by a multitude of smaller tributary drainages, ultimately empties into the Dead Sea depression near the Jordanian town of aṣ-Ṣāfī (Clark 1984; Clark *et al.* 1988). The archaeological site surfaces, which span a period of approximately 100,000 years, correspond to various lake shore and flood plain environments that can ultimately be linked to a series of Upper Pleistocene and Early Holocene climatic changes (Donahue and Beynon 1988).

The Wadi Hasa Paleolithic Project (WHPP), under the direction of G. A. Clark, recovered, during the 1984 and 1986 field seasons, excavated samples from six sites, including two Middle Palaeolithic sites: WHS 621 and

WHS 634.

WHS 621

The first site WHS 621 is an extensive (4000 m^2) scatter of (predominantly) Middle Palaeolithic artifacts. It is an open-air site on the shore of Pleistocene Lake Hasa, and lies at about 807-810 m, close to the estimated maximum elevation of the lake (+ 815 m) (Clark 1984). The abundance of Middle Palaeolithic material and the lack of clearly Upper Palaeolithic material or later industries lead Clark *et al.* (1987: 23) to suggest that the site is essentially unmixed and represents the lithic component of a slightly derived Mousterian camp site (or series of camp sites). Since it has a so-called "Tabun B" type assemblage, WHS 621 is thought to fall in the 60-40 kyr interval, relatively late in the Levantine Middle Palaeolithic sequence (Jelinek 1983).

WHS 634 ('Ayn Difla)

The second site, WHS 634 ('Ayn Difla), is a small pocket of sediment at one end of a huge rockshelter in Wādī 'Alī, a southern tributary of al-Ḥasā. It is the remnant of a much larger site, the contents of which have been eroded away. The site now covers about 40 m^2. It is located at c. 780 m above sea level and, unlike WHS 621, is not directly associated with Pleistocene Lake Hasa. The site contains up to 5 m of stratified *in situ* Middle Palaeolithic deposits and apparently no later material (Lindly and Clark 1987). The site has produced a "Tabun D" type assemblage, which has been TL-dated by Oxford University from 90-120 kyr BP (Lindly and Clark 1987; Clark pers. comm.)

Since *sample size* is in many ways more important than *sample fraction*, the samples analyzed from each site for this study were equal in number (N = 1600) (Cowgill 1975). These samples were chosen randomly in an attempt to preserve artifact proportions within each assemblage (for instance, the ratio of tools to debitage).

Mobility and the Organization of Technology

For hunter-gatherers, Binford (1980) has proposed a distinction between residential and logistical mobility. This distinction is a rough correlate of Marks and Freidel's (1977) notion of "circulating" and "radiating" settlement patterns (or at least would result in roughly similar patterns). Residential mobility refers to the simultaneous movement of most of the members of a camp. Highly mobile groups, termed "foragers", move consumers to resources and make relatively frequent moves. "Collectors", on the other hand, practice a highly logistical strategy: small, specially organized task groups leave the residential base to procure specific resources. Collectors occupy residential bases for a relatively longer period of time (e.g., several weeks, months, or an entire season), and transport resources to consumers through this kind of logistical organization. The comparatively low residential mobility of collectors is accomplished by storing resources and effectively "creating" a resource at the residential base.

Binford (1980) has argued that lithic procurement is "embedded" in settlement/subsistence systems, and that lithics can be used to monitor the extent of those systems. Mobility plays a large part in determining the nature and role of tools (Parry and Kelly 1986). High mobility should place constraints upon technology by imposing carrying costs. Since neither tools needs nor raw material availability can always be precisely anticipated, mobility simultaneously plays a part in dictating tools needs and access to raw material (Kuhn 1990). A technology based upon *curation* may fulfil many of the requirements of a highly mobile adaptation. A curated technology consists of tools that are effective for a variety of tasks, are manufactured in anticipation of use, maintained through a number of uses, and recycled to other tasks when no longer useful for their primary purposes (Chatters 1987). One significant advantage of a curated technology is its relative portability, because it permits a fixed set of tool needs to be fulfilled with a smaller number of tools and from a smaller weight of raw material.

Among more sedentary populations, portable/curatable tools would no longer have such a high degree of utility and they might instead choose to emphasize the production of new tools (rather than resharpening) as a source of fresh edges. An *expedient* technology is one that produces tools on an "as needed" basis that are used until dull, broken, or no longer required, and then discarded. It is a technique that minimizes manufacture effort, but is wasteful of raw material compared to a curated technology. Increased sedentism may allow for the "embedded procurement" of large quantities of raw material to a residential location with little extra expenditure of time or energy, and thus simultaneously relieve both the constraints of high mobility and raw material availability (Kuhn 1991: 79).

It was expected that the lithic assemblage from WHS 621, the later Middle Palaeolithic site, would exhibit greater signs of having been curated, for settlement/subsistence strategies during this time period should be more similar to the Upper Palaeolithic pattern of high residential mobility, which would tend to require higher degrees of curation. This would be manifest as (1) a high relative frequency of formal retouched tools (Dibble 1987); (2) a high relative frequency of resharpening "tertiary" flakes (Bamforth 1986); (3) a high frequency of exhausted cores (i.e., small, broken) and tools (i.e., those that are heavily utilized, broken, and/or have steep edge angles) (Shackley 1986); and (4) greater diversity of raw materials, both in terms of richness and evenness (Goodyear 1989; Kintigh 1989).

In contrast, the assemblage from WHS 634 ('Ayn Difla) was expected to exhibit signs of expediency. This would consist of (1) a high frequency of waste material (i.e., shatter, debris, minimally utilized flakes and blades) (Shackley 1986); (2) a low incidence of retouch and core preparation (Bamforth 1986); (3) all stages of core reduction, including primary/cortical debitage and cores of variable reduction intensity (Shackley 1986); and (4) a more intensive use of local raw materials (Bamforth 1986).

Results

The assemblage for WHS 621, the later Middle Palaeolithic site, conformed remarkably well with the expected patterns of a mobile/curated assemblage (TABLE 1). The assemblage exhibited greater diversity of raw material types than the earlier site, both in terms of the number of different material types represented (richness), as well as the "evenness" of the distribution (Kintigh 1989). Most notable, however, was the degree to which the assemblage from WHS 621 was fragmented, as well as the frequency of visible edge damage on the artifacts, as compared with WHS 634. WHS 634 had about 4.6 times as many complete as broken artifacts, while WHS 621 had about 1.4 times more *broken* than *complete* ones (TABLE 2). The chi square statistic associated with these data is 258.7 (ρ <0.0001). Although post-depositional processes may account for some of the fragmentation at WHS 621, heavy patination of a majority of the breaks, and a high frequency of fragmented cores, suggest that much breakage occurred close to the time of deposition and in fact resulted *in* the discard of artifacts (Baumler 1985). Additionally, the WHS 621 assemblage had edge damage on 64.3% of the artifacts, and 42% of the artifacts exhibited edge damage on more than half of the margin (i.e., they were used more than once). In contrast, WHS 634 artifacts were minimally utilized. Thirty-four percent of the assemblage showed signs of use, only 14% of which was considered intensive (TABLE 3).

Edge angle data from WHS 621 also support the mobile/curated hypothesis for the site. Fifty-nine percent of the assemblage demonstrated an edge angle greater than or equal to 45 degrees, compared with 43% of the WHS 634 assemblage.

Formal tools comprise only 9% of the WHS 621 assemblage, compared with 13% of the WHS 634 assemblage. This low percentage at WHS 621 may be due mostly to the difficulty of identifying formal tool types in such a fragmented assemblage. However, the diversity of formal tool types at WHS 621 was greater, both in terms of *richness* and *evenness* (Kintigh 1989) (TABLE 4). Approximately *90%* of the formal tools from WHS 634 are Levallois (type nos. 1-4 in the Bordes typology). The WHS 621 formal assemblage consisted of relatively fewer Levallois elements, and more retouched elements

Table 1. Summary of results.

WHS 621 (more mobile)		*WHS 634 (less mobile)*
greater diversity of raw material types	C	lesser diversity of raw material types
larger, heavier artifacts	NC	smaller, lighter artifacts
high frequency of unidentified core fragments	C	low frequency of unidentified core fragments
highly fragmented artifacts	C	mostly complete artifacts
few complete blades many complete flakes	C?	many complete blades fewer flakes
heavily utilized	C	not heavily utilized
heavily retouched	C	not heavily retouched
incidence of retouched pieces (9%)	-	incidence of retouched pieces (13%)
more diverse retouched tool assemblage	C	less diverse retouched tool assemblage
edge < steeper - more retouch	C	edge < sharper - less retouch
spine-plane < varies from edge <	C	spine-plane < consistent with edge <
dorsal characteristics	-	dorsal characteristics
fewer prepared platforms	NC	more prepared platforms

C = consistent with hypothesis

NC = not consistent

- = no difference

Table 2. Condition of artifact.

WHS 634

Condition	Flake	Blade	All Artifacts
	Frequencies		
Complete	601	428	1072
Proximal Fragments	31	73	105
Distal Fragments	27	59	86
Medial Fragments	18	24	43
Total Fragments	76	156	234
Complete/Fragment Ratio	7.91	2.74	4.58

WHS 621

Condition	Flake	Blade	All Artifacts
	Frequencies		
Complete	447	103	619
Proximal Fragments	191	91	295
Distal Fragments	176	61	242
Medial Fragments	212	69	329
Total Fragments	579	221	865
Complete/Fragment Ratio	0.77	0.47	0.72

Table 3. Extent of utilization.

WHS 634

Extent of Utilization	*Frequency*	*Percent*
>50% of Margin	228	41.2
<50%, >25% of Margin	138	25.0
<25% of Margin	124	22.4
Sporadic	63	11.4
Total Utilization	553	100.0
No Utilization	1048	

Utilization/No Utilization Ratio = 0.52

WHS 621

Extent of Utilization	*Frequency*	*Percent*
>50% of Margin	670	65.0
<50%, >25% of Margin	220	21.3
<25% of Margin	109	10.6
Sporadic	32	3.1
Total Utilization	1031	100.0
No Utilization	573	35.7

Utilization/No Utilization Ratio = 1.80

(e.g., various side scrapers, notches, and denticulates) (TABLE 4).

Contrary to the expectations, there was a low incidence of resharpening or "trimming" flakes associated with the WHS 621 assemblage. This was probably due to the fact that WHS 621 is a slightly derived, open-air site and that post-depositional erosional processes carried away most of the smaller artifacts.

Nonetheless, these data are remarkably consonant with much of what is expected from an assemblage that represents the remains of behaviors associated with the discard of exhausted, used-up tools, and the maintenance activities associated with the gearing-up of tool kits for the next move.

In contrast, the WHS 634 assemblage, as indicated above, was, in many respects, a more expedient assemblage, exhibiting a higher frequency of shatter, little utilization and retouch, and fewer broken/exhausted pieces, all of which were manufactured from a more limited set of raw material sources than was the case at WHS 621. However, the assemblage also demonstrated aspects of variability that were not consistent with the "effort minimization" goal, which is usually part of the notion of expedience. For instance, the frequency of blades in the assemblage was remarkable. Of the 1600 artifacts analyzed from WHS 634, 584 of them were blades (about 37% of the total assemblage). Not only was the frequency of blades notable, but also the difference with which they were manufactured, compared to WHS 634 flakes, as well as the artifacts from WHS 621. Forty percent of the WHS 634 blades had prepared (dihedral or multi-faceted) platforms; no other artifact category from either site had an incidence of faceted platforms greater than 16% (TABLES 5 and 6). This suggested an attempt at obtaining greater control over the size and shape of blades at WHS 634. In addition, the thickness and edge angle of WHS 634 blades vary little compared with the other artifact categories. Correlation coefficients were high for length, width, and thickness of flakes at WHS 634 and flakes and blades at WHS 621 (TABLES 7 and 8). However, for WHS 634 *blades*, thickness predicted length and width poorly (Pearson's r = 0.307 and 0.327 respectively — TABLE 8). This was due to the fact that, while blade lengths and widths varied predictably with the size of the core being reduced, thickness did not. And lastly, WHS 634 blades had edge angles which were remarkably symmetrical and narrow in distribution (Potter 1991). This leptokurtosis was most likely associated with their unvarying, "standardized" thickness. This suggested a real effort to optimize the number of blades struck from a core (without making them so thin that they break when manufactured or used), yet preserving an edge sharp and strong enough for the anticipated range of functions.

Table 4. Formal tool frequencies.

Bordesian Type	*WHS 634*	*WHS 621*
1 Typical Levallois Flake	52	38
2 Atypical Levallois Flake	3	1
3 Levallois Point	103	21
4 Retouched Levallois Point	6	6
6 Mousterian Point	0	2
9 Straight Side Scraper	2	5
10 Convex Side Scraper	4	10
11 Concave Side Scraper	2	7
12-17 Double Side Scraper	0	10
19 Other Side Scraper	0	3
32 Burin	2	11
38 Naturally Backed Knife	2	0
42 Notch	6	9
43 Denticulate	0	21
44 Alternate Flaked Tip	0	1
47 Piece with Alternate Retouch	0	1
Total Sample	182	146

Discussion

In an expedient lithic technology, sharp but not particularly durable, fresh edges are the primary objective, often with little regard for raw material waste or for the potential reuse of tools. A curated technology, on the

Table 5. Blade platform frequencies.

Platform Type	*WHS 634*		*WHS 621*	
	count	*%*	*count*	*%*
Unmodified	14	03.3	1	00.9
Plain	189	44.6	74	73.3
Dihedral	49	11.6	10	09.9
Multi-faceted	172	40.5	16	15.8
Totals	424	100.0	101	99.9

Table 6. Flake platform frequencies.

Platform Type	*WHS 634*		*WHS 621*	
	count	*%*	*count*	*%*
Unmodified	52	08.7	8	01.8
Plain	422	70.7	333	75.5
Dihedral	58	09.7	26	05.9
Multi-faceted	65	10.9	74	16.8
Totals	597	100.0	441	100.0

Table 7. Correlation matrices (Pearson's r) for variables length, width, thickness for flakes.

WHS 634

	Length	*Width*	*Thickness*
Length	1.000		
Width	0.532	1.000	
Thickness	0.581	0.532	1.000

WHS 621

	Length	*Width*	*Thickness*
Length	1.000		
Width	0.653	1.000	
Thickness	0.614	0.617	1.000

Table 8. Correlation matrices (Pearson's r) for variables length, width, thickness for blades.

WHS 634

	Length	*Width*	*Thickness*
Length	1.000		
Width	0.667	1.000	
Thickness	0.307	0.327	1.000

WHS 621

	Length	*Width*	*Thickness*
Length	1.000		
Width	0.780	1.000	
Thickness	0.642	0.559	1.000

other hand, produces tools that can be reused. Large wide flakes are best suited for curation and reuse. The larger and wider the flake, the more it can be resharpened. Following this line of reasoning, Marks (1987) and Kuhn (1990) suggest that "ovoid" blanks, rather than elongated ones, may be produced in an attempt at curation (i.e., they can be reworked more intensively than lamellar blanks). Blades are not so well suited for curation. They are, by definition, less than half as wide as they are long. If, however, the objective is a lot of fresh edges (e.g., if there is a functional preference for long, sharp cutting edges) and one does not have to carry the core around (as a more mobile adaptation necessitates), a reduction strategy that produces blades of a standardized thickness maximizes fresh, usable edges that can be efficiently replaced rather than resharpened.

It is obvious from the above that the assemblage from WHS 634 cannot simply be considered an "expedient" assemblage. It appears that something other than the minimization of "manufacture effort" selected for some of the technological behaviors represented in the rock-shelter deposits. The "bladey-ness" of the assemblage suggests an attempt to maximize the amount of cutting-edge in relation to volume. It is suggested here that a less mobile adaptation might allow for the manufacture of less portable/curatable, but functionally more efficient tools, and that blade core reduction is just such a technique.

Blade- and flake-based technologies, then, seem to be different answers to different problems. In the Levant this is especially important because, unlike Europe, the transition from the Middle to the Upper Palaeolithic was not a simple "flake to blade" transition (but cf. Clark and Lindly 1989 for a different view of the European transition). Blades dominate many assemblages very early in the Levantine Palaeolithic sequence, and spatial variability seems to muddle the picture as well (e.g., "Tabun D" type assemblages, an early Levantine Mousterian assemblage type in the north that is, by definition, very elongated and "bladey", persists very late in some parts of the southern Levant). Thus it is important to understand why an assemblage is flake- or blade-dominated rather than simply noting that it is and then proceeding to date it using this empirical observation.

Marks and Volkman (1983), based upon work at Ksar Akil and other sites in Lebanon, as well as data recovered from Boker Tachtit, suggest that, rather than the European-based notion of lithic technologies "evolving" from a flake to a blade technology over the Middle to Upper Palaeolithic transition, artifact morphologies in the Levant cycled back and forth through time between flakes and blades:

> This cycle goes from on-axis preparation, producing elongated "Levallois" points and blades during the Early Levantine Mousterian (e.g., Tabun D), to quite typical Levallois peripheral preparation of cores, producing ovoid Levallois flakes and broad-based Levallois points in the later Levantine Mousterian (e.g., Tabun C and B) and finally, back to a tendency toward unidirectional preparation and the production of elongated blanks in the transitional assemblages of Lebanon (1983: 14).

This cycling back and forth between blade and flake-dominated assemblages suggests that the environmentally driven model proposed by Marks and Freidel (1977) is probably too simplistic. Much of the data used to monitor environmental changes during the Middle and Upper Palaeolithic in the southern Levant is either nonexistent or is so coarse-grained as to result in gross oversimplification. Although there is little doubt that a major long-term drying trend took place during the later Middle and throughout the Upper Palaeolithic in the southern Levant, there were also most likely some relatively significant, short-term fluctuations through time, as well as much variation across space. The observed cycling between flake and blade technologies through time and the variable rates of cycling across space were probably adaptive responses to the different problems imposed upon the prehistoric Levantines by these archaeologically less-visible climatic fluctuations. Without more fine-grained environmental data for a more extensive area than that now available, this scenario will unfortunately remain just that, a scenario. It can only really be tested when southern Levantine palaeoclimatic data of sufficiently high resolution become available.

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