A new approach to interpreting late Pleistocene microlith industries in southwest Asia

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Archaeologists have long assumed that morphological variability in microliths primarily reflects cultural differences among the makers. This forms the basis for differentiating major cultural/temporal traditions in the late Epipalaeolithic of southwest Asia. An alternative explanation for morphological variability is proposed which emphasizes the dynamic aspects of lithic technology in hunter–gatherer societies and questions current explanations of culture change.

Currently, the earliest known evidence for the appearance of both food-producing economies and social complexity is found in southwestern Asia. In the belt of forest and steppe at the eastern end of the Mediterranean, known as the Near Eastern Levant, the transition to food production began between 14,500 and 10,000 b.p., in the context of late Pleistocene foragers known collectively as the Levantine Epipalaeolithic.

Although a considerable body of floral and faunal remains provides direct economic evidence for this time period, the cultural framework within which these data are interpreted largely derives from explanations of variability in assemblages of chipped stone artefacts. Furthermore, while radiocarbon dates are available for a few sites, the major chronological divisions of the Levantine Epipalaeolithic also are defined predominantly on the basis of morphological variability in the lithic assemblages.

Many Levantine prehistorians see variation as essentially stylistic in Epipalaeolithic chipped stone assemblages, permitting the identification of discrete ethnic groups (Bar-Yosef 1991; Henry 1989). For example, Henry (1989: 175) has argued for ethnically distinct band clusters on the basis of variations in microlith frequencies among Geometric Kebaran assemblages. The more homogeneous Natufian industry that follows is felt to indicate the coalescing of these ethnic groups into socially more complex societies in which agriculture is believed to have originated (Henry 1989: 175; see also McCorriston & Hole 1991).

Especially important for cultural and chronological divisions of the Epipalaeolithic are the frequencies of microliths and their production residues. Serving as cutting edges of compound tools (FIGURE 1), Levantine microliths occur in geometric (e.g. triangles, rectangles, and lunates) and non-geometric (e.g. arched backed, straight backed and scalene bladelets) forms. Typologically, the most distinctive residues from microlith production are the small segments that result from a method of sectioning bladelets known as the microburin technique.

Currently, the Levantine Epipalaeolithic is organized into three major cultural divisions, the Mushabian, the Geometric Kebaran and the Natufian. The Mushabian is characterized by high frequencies of arched backed bladelets, scalene bladelets and La Mouillah points, and high microburin frequencies (Henry 1989: 91–3). Most Mushabian sites are in the arid regions of the southern Levant, particularly the central Negev and northeastern Sinai, and date to *c.* 14,000–12,000 b.p. Geometric Kebaran industries are defined by high frequencies of straight backed bladelets and trapeze/rectangles, and very low microburin frequencies (Henry 1989: 93). The

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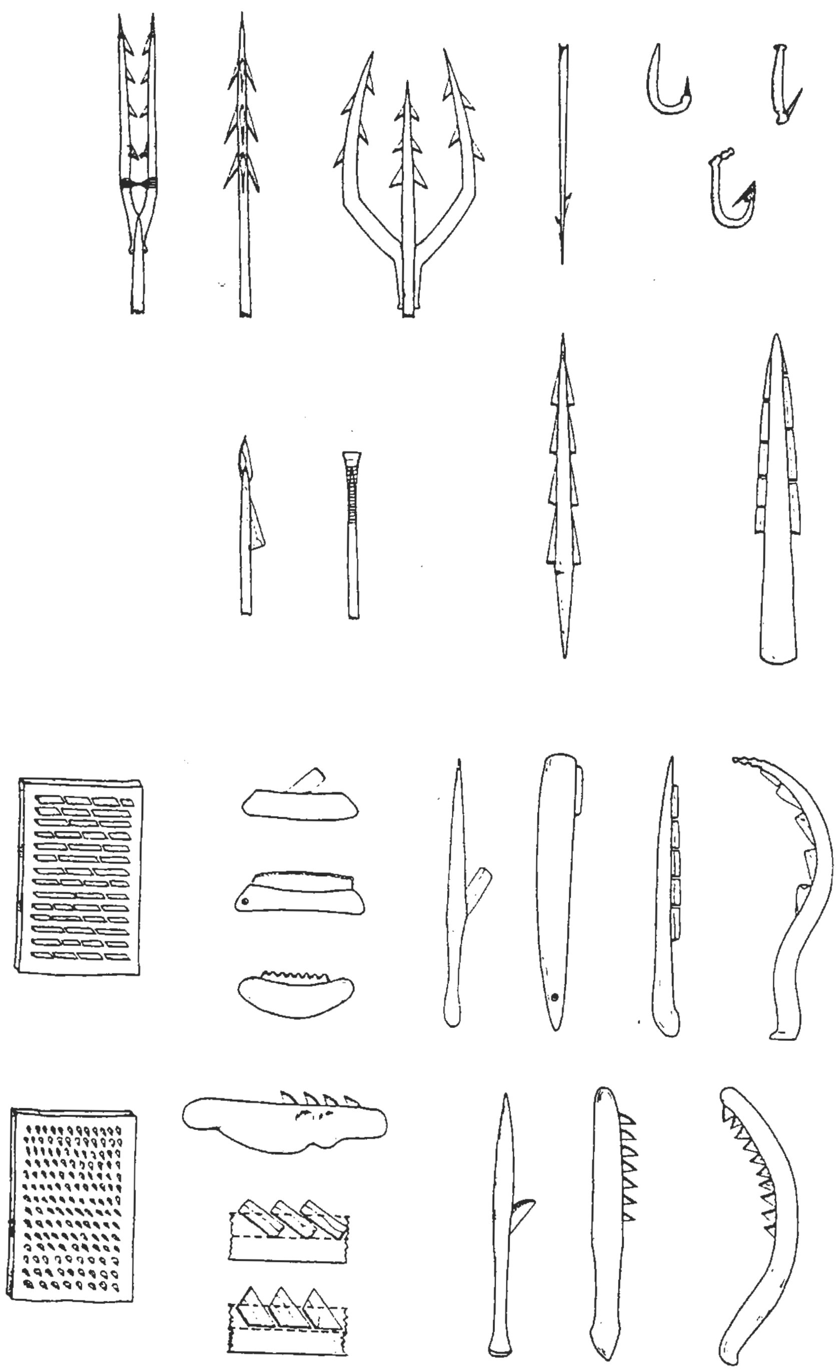


FIGURE 1. *Worldwide ethnographic and archaeological examples of the variety of uses and mounting of microliths in compound tools. (From Clarke 1976: figure 2.)*

Geometric Kebaran is generally contemporaneous with the Mushabian, at *c.* 14,500–12,500 b.p., and sites are found in both arid and Mediterranean zones of the southern Levant. Natufian assemblages are characterized by high frequencies of geometric microliths (predominantly lunates), arched and straight backed bladelets, and high microburin frequencies (Henry 1989: 94). This industry dates to 12,500–10,000 b.p., and most sites are situated in the Mediterranean zone of

GEOMETRIC KEBARAN ASSEMBLAGES

A 302	Lagama North VIII	Nahal Rut 48d	Shunera XII
Azariq I	Maaleh Ziq	Nahal Rut XI	Shunera XIIa
Azariq II	Mushabi XIV L2	Nahal Rut XIII	Shunera XIIb
Azariq VIIa	Mushabi XVII	Nahal Rut XVII	Shunera XXV
Azariq VIII	Mushabi XVIII	Nahal Sekher 22	Wadi Sayakh
Azariq XVI	Nahal Lavan 105	Nahal Sekher 81/M	Zin D 5
Azariq XVIII	Nahal Rut 48a	Qadesh Barnea 8	Zin D 101C
Halutza 5	Nahal Rut 48b	Shunera I	
Lagama North IV	Nahal Rut 48c	Shunera III	

MUSHABIAN ASSEMBLAGES

Azariq III	Halutza 94 all	Mushabi V	Nahal Rut IV
Azariq IX	Hamifgash IV	Mushabi XIV/1	Nahal Rut VII
Azariq VIIb	Har Harif G IX	Mushabi XIX	Nahal Sekher 23
Azariq X	Har Harif HF Ia	Nahal Lavan 106	Nahal Sekher 81/M1
Azariq XII	Har Harif HF Ib	Nahal Lavan 107	Nahal Sekher 81/M2+
Azariq XIX	Har Harif HF II	Nahal Lavan 116	Nahal Sekher 81/M3
Azariq XX	Har Harif K5	Nahal Lavan 1003	Ramat Matred II
Ein Qadis II	Har Harif K6	Nahal Lavan 1009	Ramat Matred III
Ein Qadis VI	Har Harif K7	Nahal Lavan 1010W	Shluhat Qeren I
Haj	Har Harif K9	Nahal Nizzana II	Shluhat Qeren II
Halutza 5B	Har Lavan II	Nahal Nizzana VIII	Shunera II
Halutza 83	Kurnub	Nahal Nizzana X	Shunera IV
Halutza 84	Maaleh Ramon West II	Nahal Nizzana XI	Shunera VII
Halutza 87	Mitzpeh Shunera I	Nahal Nizzana XII	Shunera VIII
Halutza 89	Mitzpeh Shunera III	Nahal Nizzana XIV	Shunera XXI
Halutza 93			

NATUFIAN ASSEMBLAGES

Ain Mallaha Ib	Givat Hayil I	Kebara B	Salibiyah I
Ain Mallaha Ic	Halutza 7	Nahal Oren V	Shukbah B
Ain Mallaha IV	Halutza 82	Nahal Oren VI	Shunera VII
Azariq XV	Halutza 83	Nahal Rut VI	Shunera XIII
Beidha	Hayonim Cave B lower	Nahal Sekher VI	Shunera XIV
El Wad B1	Hayonim Cave B upper	Oumm Qala'a	Shunera XVIII
El Wad B2	Hayonim Terrace loc. 4	Rosh Horesha	Tabaqa
Erq el-Ahmar A2	Hayonim Terrace upper	Rosh Zin	Tor Abu Sif
Fazael IV		Saflulim	Zoueitina

TABLE 1. *Sites and assemblages used in this study.*

the southern Levant.

In this paper, we use data from 130 Epipalaeolithic assemblages from 115 Levantine sites (TABLE 1) to examine microlith technology in these Late Pleistocene industries. We suggest that differences in microburin abundance and variation in microlith form are better viewed within a technological continuum of microlith manufacture, use and discard than as discrete, predetermined types. This model

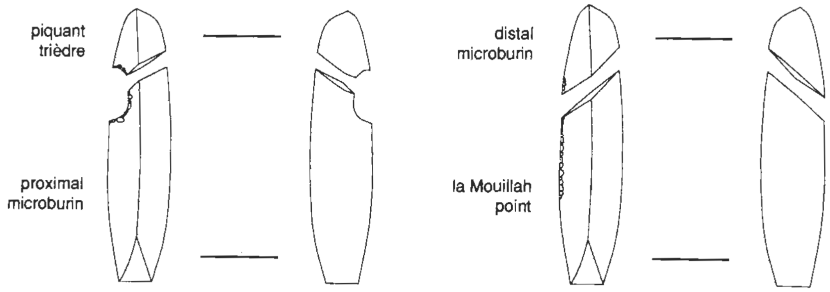


FIGURE 2. *Lithic elements resulting from the microburin technique. (After Henry 1989.)*

is used to reassess the behavioural significance of patterning in the lithic assemblages of Levantine Epipalaeolithic foragers.

The microburin technique

The microburin technique is a method of truncating or segmenting a bladelet, via a controlled snap, prior to further modification. It is an intermediate stage in microlith production and the resulting pieces are rarely the final end-product (see Bordes 1957; Henry 1974; Tixier 1974). The characteristic forms of debitage produced by the microburin technique are a microburin and a *piquant trièdre*, or La Mouillah point (Henry 1989: 89) (FIGURE 2). If the fracture scar is located on the interior bladelet surface, the piece is designated a microburin. The remaining bladelet section, with the fracture scar on the exterior surface, is called a *piquant trièdre* or a La Mouillah point[1]. While the *piquant trièdre* or La Mouillah point can be further transformed into a backed bladelet or a geometric microlith, it is usually assumed that the microburin is discarded without further modification (but see below).

As previously indicated, microburin debitage is used to define culture-stratigraphic units of the Levantine Epipalaeolithic. There are several recognized variants of the microburin technique (FIGURE 3). Henry (1974; 1989) has proposed that these variations served to produce three distinct tool types (arched backed bladelets, triangles and lunates) and correspond roughly with the Mushabian, the Geometric Kebaran, and the Natufian.

Fundamental to interpreting the significance of microburin technology is the ability of the commonly used ratios of microburins to microliths (i.e. microburin indices) to measure the intensity of microburin technology (see Byrd 1989 for a summary of various microburin indices). The use of these indices as cultural markers assumes that manufacturing debris (microburins) and tools (microliths) were regularly discarded together in consistent frequencies. Among mobile hunter-gatherers, however, tool manufacture (producing discarded microburins) and tool maintenance (resulting in discarded microliths) may not co-occur equally or at all at different sites (e.g. Goring-Morris & Avner 1985; Marks & Larson 1977: 205), and factors such as raw material availability, mobility and site function may influence what remains in the archaeological record (Bamforth 1986; 1991; Barton 1990; Kuhn 1991).

Even if microburins and microliths co-vary consistently in discard patterns, microburin frequency in assemblages may not reflect the extent to which the technique was used. As previously mentioned, it is generally assumed that microburin sectioning was applied only once to each bladelet, creating a 1:1 ratio of microliths to microburins (i.e. microburin indices of *c.* 50), and that microburins were rarely, if ever, transformed into microlithic tools.

This need not be the case, however. Restrictions in the availability of suitable raw materials can make it necessary to conserve and intensify the use of the material at hand by creating more microliths (i.e. more usable cutting edge) from bladelet blanks. This can be accomplished by modifying microburins (as well as *piquants trièdres* or La Mouillah points) into microliths — a process leaving them unrecognizable as manufacturing debris. If bladelets are long enough, they also can be sectioned more than once, creating multiple microliths from a single bladelet and only one (or no) discarded microburin. These processes would re-

1 The differences between a *piquant trièdre* and a La Mouillah point are due to the manner in which the bladelet was snapped using either a notch (*piquant trièdre*) or through backing (La Mouillah point).

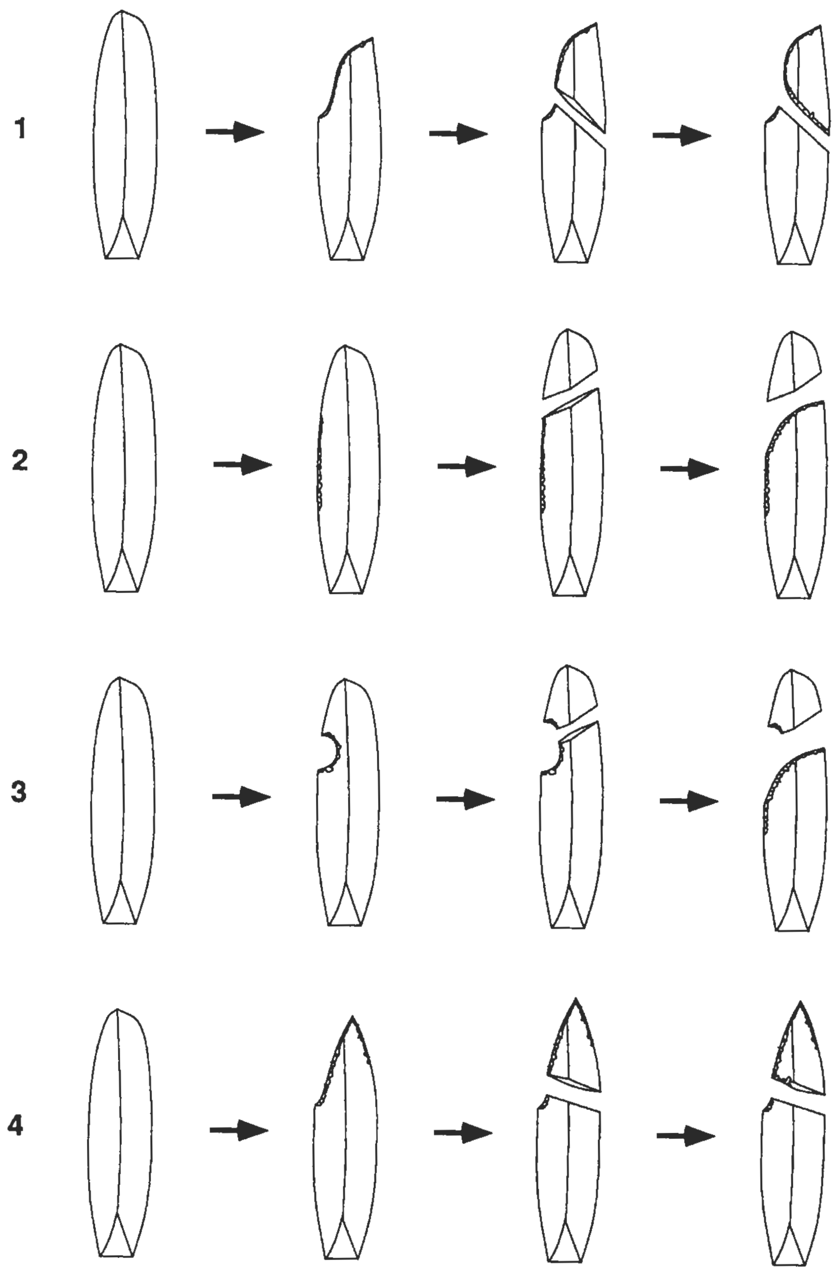


FIGURE 3. *Different ways of sectioning bladelets with the microburin technique. Method 1 is traditionally associated with the Natufian, methods 2 and 3 with Mushabian and method 4 with the Geometric Kebaran, especially at Ein Gev IV. (After Henry 1974; 1989.)*

sult in low microburin indices, and give the impression that the microburin technique was rarely used or absent. Given these considerations, it is useful to re-examine the role of the microburin technique in relation to microlith technology as a whole, within the major industries of the Levantine Epipalaeolithic.

FIGURE 4 compares mean lengths of unretouched bladelets and microlithic tool lengths for the Mushabian, Geometric Kebaran and Natufian. Mushabian bladelet blanks have a mean length of 31 mm (Henry 1989). Mushabian microlithic tools (i.e. backed bladelets) have an overall mean length of 24·87 mm in 59 Mushabian and Ramonian assemblages reported by Goring-Morris (1987) (TA-

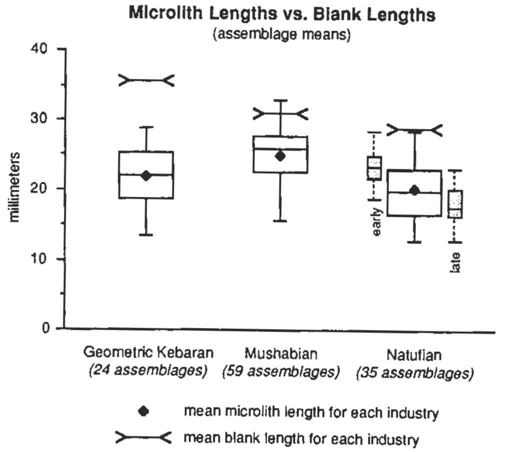


FIGURE 4. *Comparison of mean bladelet lengths and mean microlith lengths for Geometric Kebaran, Mushabian and Natufian assemblages. Mean lunate lengths for early and late Natufian also shown for comparison. (Data from Byrd 1989; Byrd & Rollefson 1984; Henry 1989; Goring-Morris 1987; Marks & Larson 1977; Olszewski 1986a; Valla 1984.)*

BLE 1). The modal length of Mushabian backed bladelets from the northern Sinai, reported by Phillips & Mintz (1977: figure 82), is between 20 and 30 mm. On the average, backed bladelets account for 80% of unmodified blank length in Mushabian assemblages[2]. This would suggest that the microburin technique was used to produce only one backed bladelet from bladelet blanks, and the ratio of microburins to microliths produced should be about 1:1. This would give the Mushabian a restricted microburin index ('rImbt') of about 50 (see Henry 1974). In fact, combined mean 'rImbt' for all Mushabian assemblages is slightly less than 60 (Henry 1989: 93).

Low microburin indices differentiate the Geometric Kebaran from the Mushabian, and have been interpreted as evidence that the microburin technique was little utilized for the manufacture of geometrics. This is thought to signal different cultural traditions of lithic manufacture for the Mushabian and contemporaneous Geometric Kebaran. We suggest, alternatively, that low microburin indices in Geometric Kebaran assemblages may be more a function of the manner in which the microburin technique was applied, in response to a need to utilize lithic material more conservatively, rather than a tradition of using the technique only rarely.

According to Henry (1989: 93), Geometric Kebaran bladelet blanks have a mean length of 35·8 mm, considerably longer than Mushabian bladelets. Geometric Kebaran microliths, however, are shorter than their Mushabian equivalents (FIGURE 4). At site D5 in the Central Negev, geometrics range from *c.* 9 mm to 30 mm in length, with a mean length of 17·2 mm (Goring-Morris 1987: 128). In the northern Sinai, the modal length of geometrics from Lagama North VIII is 20–25 mm (Bar-Yosef & Goring-Morris 1977: figure 53). For an additional 24 assemblages reported by Goring-Morris (1987), trapeze/rectangle forms have an overall mean length of 21·97 mm. In contrast to Mushabian assemblages, Geometric Kebaran microliths only account for 61% of the average length of unretouched bladelets.

These data suggest that two (or more) microliths were produced from many Geometric Kebaran bladelets, rather than a microlith and a discarded microburin. If, as these data suggest, all segments of a sectioned bladelet were transformed into microliths, the requisite backing would obscure characteristic microburin scars. At most, one discarded microburin would be produced (from truncating the distal-most segment) for two or more geometric forms, and the process need not result in the discard of any recognizable microburin debitage — even if the microburin technique was commonly used to section bladelets. This makes more efficient use of raw material by utilizing the entire bladelet and producing minimal unusable debitage.

As previously noted, Natufian assemblages have high microburin indices, suggesting that most of the blank length was utilized by the production of a single microlith. As a whole, Natufian bladelet blanks, at 29 mm, are shorter than either the Mushabian or Geometric Kebaran (Henry 1989: 94) (FIGURE 4). Lunate length data is available from 35 Natufian assemblages. Mean values range from 13 mm to 28 mm, with a combined mean of 19·95 mm. Overall, 69% of the bladelet blank ap-

2 Goring-Morris (1987) considers the Mushabian and Ramonian to be separate industries. However, using Henry's (1989) terminology we have grouped them together. If the mean values for backed bladelet lengths are calculated separately, the Mushabian mean length is 23·90 mm (77%) and the Ramonian is 25·71 (82%).

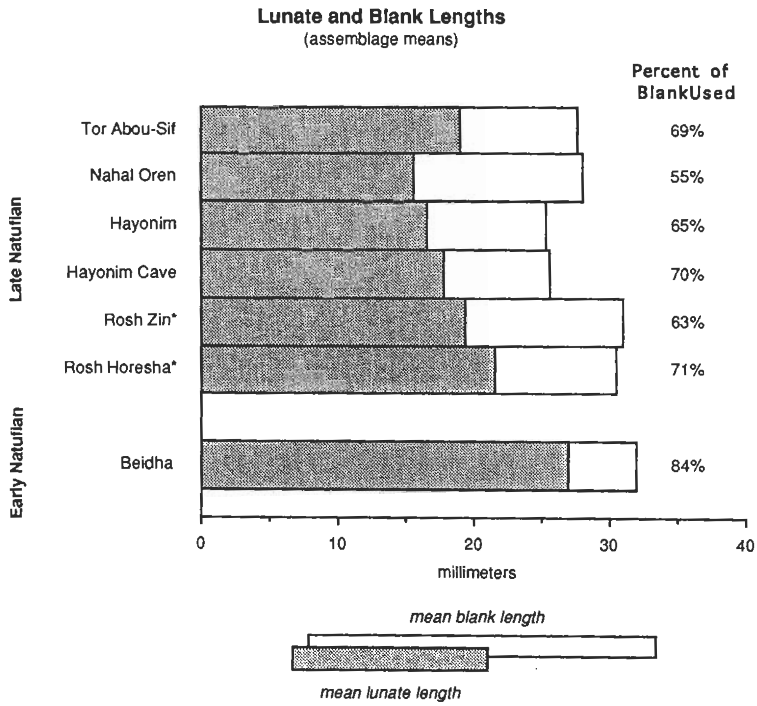


FIGURE 5. *Comparison of mean lunate length and mean blank length of individual Natufian assemblages. Note differences in early and late Natufian assemblages. (Data from Byrd 1987; Henry 1973; Marks & Larson 1977; Olszewski 1986a.)*

pears to have been utilized by the microlithic tool in the Natufian. This is intermediate between Mushabian and Geometric Kebaran values.

There is considerable variability in mean blank length and mean lunate length among individual Natufian sites (FIGURE 5). While these data suggest that only one geometric was generally produced from a single Natufian bladelet blank, multiple geometrics from some blanks also were possible. Interestingly, while a time-transgressive reduction in lunate length is recognized for the Natufian (Bar-Yosef & Valla 1979; Olszewski 1986a), this may not correspond to a reduction in bladelet blank length. Although available data are limited, early Natufian lunates appear to comprise a much greater portion of bladelet lengths than do late Natufian lunates (FIGURE 5). Such a shift to the production of more, smaller lunates per bladelet may be responsible for the concomitant change from an emphasis on bifacial (i.e. Helwan) backing to unifacial backing, probably performed on an anvil, because it was more difficult to hand hold the smaller lunates to back them bifacially (see Edwards 1987: 204–7).

Discussion

Comparison of the use of the microburin technique among these three divisions of the Levantine Epipalaeolithic suggests some interesting trends. In Mushabian and (especially early) Natufian assemblages, microliths tend to comprise the greatest portion of the original bladelet blank and the discarded microburins are too small to be transformed into a tool. The high microburin indices in these industries are a product of these 1:1 ratios between microburins and microliths.

In contrast, microburins are rare, but not absent, in Geometric Kebaran assemblages, and this industry generally has longer bladelets and shorter microliths. This suggests bladelets were sectioned into two or more microliths, possibly by the microburin technique, but leaving little or no characteristic microburin debitage. The ability to increase the efficiency of lithic raw materials use in this way would be desirable among more mobile hunter/gatherers where movement into areas with low or unknown raw material availability, combined with a need for portable material culture, would encourage conservation of lithic materials. Such behaviour has been reported among comparable Holocene (i.e. Archaic) foragers in the North American west (Bamforth 1991).

Smaller lunate length relative to bladelet length may also reflect the need for more efficient use of bladelets in the late Natufian. There is some evidence that late Natufian settlements represent a less sedentary adaptation than do early Natufian occupants (Moore & Hillman 1992; Olszewski 1993a). If true, the size reduction for late Natufian lunates may be analogous to the Geometric Kebaran pattern described above. However, factors other than increased mobility also can encourage raw material conservation, including higher population densities, restricted access to raw material sources due to social circumscription, and simple long-term depletion of convenient sources of this non-renewable resource. Given the variability in blade length, the size of available raw material also may play a role. However, at 36+ mm, even the longer Geometric Kebaran blades do not necessitate a very large core.

Differences in the availability of raw material and the intensity of its use have the potential to affect microburin indices to a significant extent. It can be argued that, as generally envisaged by prehistorians, the microburin technique is somewhat wasteful of lithic materials in that it results in a non-utilized bladelet segment. The explanation proposed above for the low microburin indices in Geometric Kebaran assemblages allows for variation in the application of this technology to respond to different conditions of resource availability. As such it is perhaps more in line with ethnographic observations of the flexibility in forager behaviour in regard to lithics than is an explanation that postulates that variation in the extent to which the technique was used was primarily due to cultural preference. From this perspective, the Mushabian and Geometric Kebaran may represent different facies in the flexible lithic technology of early Epipalaeolithic hunter–gatherers, responding to variations in settlement mobility and raw material availability.

Microlith typologies

The preceding discussion focused on the microburin technique in Levantine Epipalaeolithic industries. However, this technique is but an initial step in production of microlithic artefacts for use in compound tools. As previously mentioned, variations in the frequencies of different types of microliths are widely used to identify Late Pleistocene social units in the Levant. While function, style and technology all contribute to typological variability (Jelinek 1976), function and style are widely felt to play the strongest role in Epipalaeolithic industries. That is, each type is thought to have served a specific function (or related set of functions) and/or to indicate a culturally-determined choice from a suite of functionally equivalent morphologies. Implicit in this view of lithic variability is the idea that each type is a discrete, predetermined, 'ideal tool' form that is discovered (rather than invented or created) by prehistorians (Clark & Lindly 1991).

However, a number of recent studies have suggested that at least some (and perhaps most) lithic types recognized by prehistorians actually may be arbitrarily defined stages in the use-life of a few morphologically dynamic stone artefact classes, rather than discrete functional or stylistic forms (Barton 1990; Coinman 1990; Dibble 1987). This more technologically oriented explanation suggests that the morphology at the time of discard may reflect factors such as initial blank morphology, production sequences and variation in the amount of use more than specific functions or ethnic identity. It is from this latter perspective we examine morphological variability in the two major microlithic artefact classes for the Levantine Epipalaeolithic, backed bladelets and geometric microliths.

Backed bladelets

Of the many types of backed bladelets recognized (see e.g. Hours 1974), those generally considered important markers for chronology and for the identification of archaeological cultures in the Levantine Epipalaeolithic are straight backed bladelets, La Mouillah points, scalene bladelets and arched backed bladelets (Henry 1989). That is, temporally and/or spatially distinct cultural entities in the Levantine Epipalaeolithic are believed to have produced significantly different quantities of these four major kinds of backed bladelets. We suggest, however, that this typological variability can be better explained in terms of a technological model, schematically represented in FIGURE 6, in which the four types, along with microburin

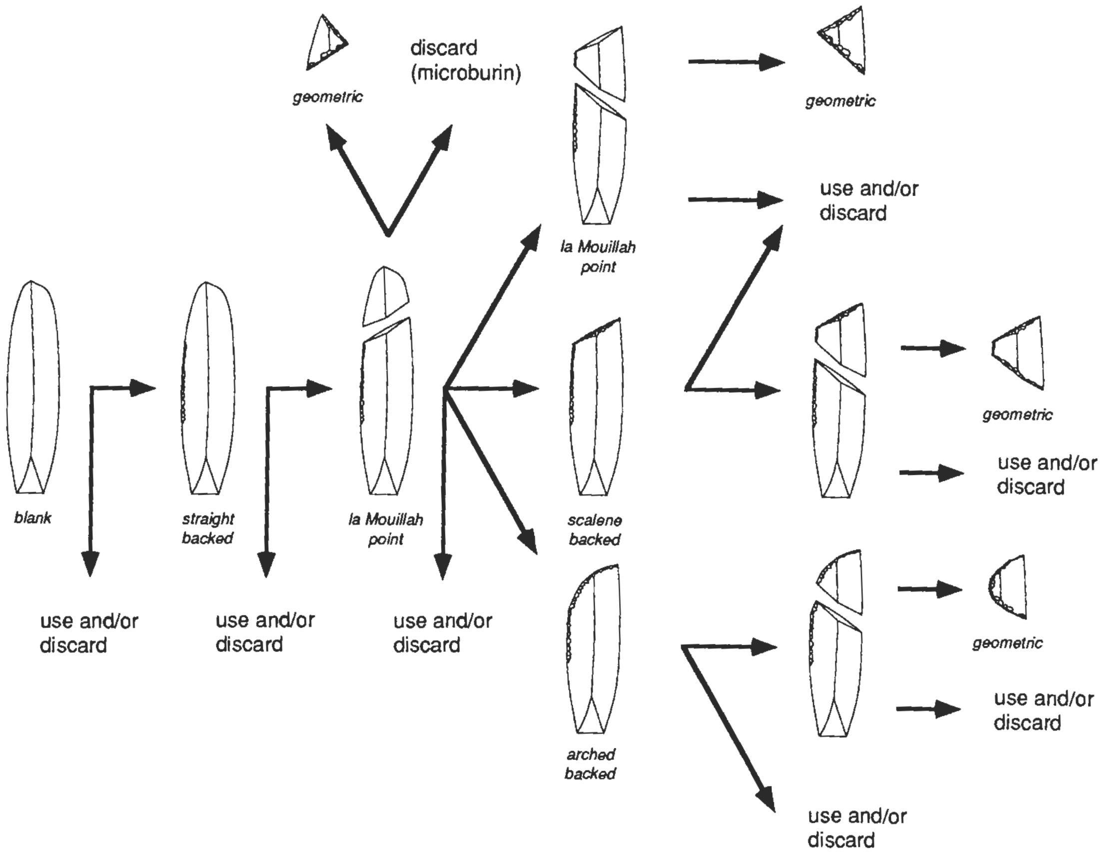


FIGURE 6. *Schematic representation of proposed manufacturing and use trajectory for backed bladelets and geometrics.*

debitage, comprise the residues of different stages of microlith production.

First, a bladelet blank is backed, producing a straight backed bladelet. While this 'type' can be used and discarded, it also serves to prepare a bladelet for truncation or segmentation via the microburin technique. The subsequent microburin truncation results in a La Mouillah point which, again, can be used and/or discarded or may serve as a stage for further modification (Henry 1989: 93; Phillips & Mintz 1977: 153). From a La Mouillah point, either a scalene bladelet or arched backed bladelet can be formed, depending on whether the backing is angled or rounded (FIGURE 6). It is further possible to manufacture geometric forms from these backed bladelet types by again applying the microburin technique and/or additional backing (see below and FIGURE 6). An analogous manufacturing relationship between truncated bladelets and scalenes has been proposed by Olszewski (1993b) for the Epipalaeolithic (i.e. Zarzian) assemblage from Warwasi rockshelter in the Zagros Mountains.

If the backed bladelet types most commonly used as markers for archaeological cultures are simply stages in the manufacture of other types, their ability to serve as 'type fossils' seems questionable. Similarly, traditional stylistic/ethnic or functional explanations for differences in backed bladelet type frequencies among assemblages seem considerably less applicable. The model proposed above suggests that Levantine Epipalaeolithic sites with high frequencies of straight backed bladelets would represent locales in which initial residues of microlith manufacture predominate, while those with high frequencies of scalene or arched backed bladelets result either from the discard of end-products (presumably from the

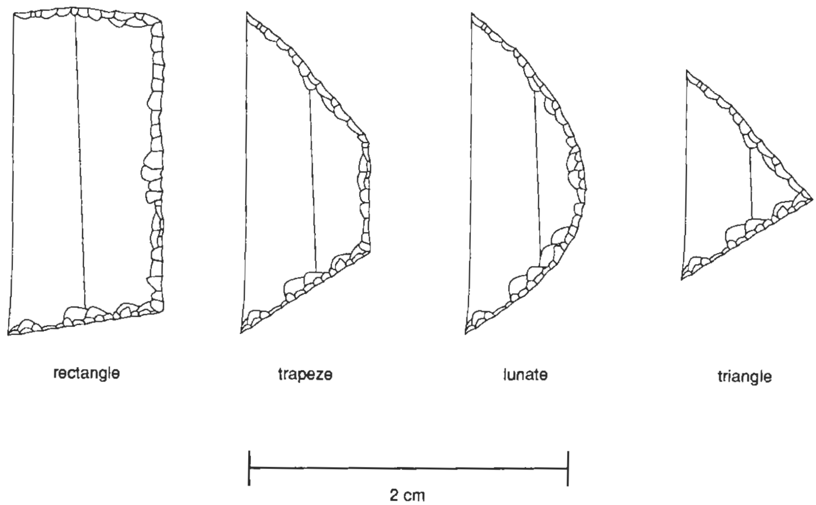


FIGURE 7. *Schematic representation of major classes of geometric microliths.*

maintenance of composite tools) or the production of geometrics. Sites with other forms would indicate activities at intermediate points on this technological continuum. Factors affecting these aspects of lithic assemblage composition may include the duration of occupation at a site, the distance to raw material sources and site function. Such considerations may prove more relevant to understanding lithic variability than ethnicity or the specific functions performed with different microlith forms.

Geometrics

The major geometric microlith classes of the Levantine Epipalaeolithic are rectangles, trapezes, triangles, and lunates (FIGURE 7). As with backed bladelets, the relative frequencies of these types are used to differentiate cultural and temporal divisions of the Levantine Epipalaeolithic. While typologies inherently require that artefacts be sorted into discrete classes, morphological variability in geometrics is in fact quasi-continuous, with intermediate morphological forms (Phillips & Mintz 1977: 153) (FIGURES 7 & 8).

With respect to function, the specific tasks for which geometrics were used are not completely understood (see e.g. Clarke 1976). As these artefacts were too small to be easily hand held, they probably were hafted in composite tools (Bar-Yosef & Goring-Morris 1977: 124; Clarke 1976; Henry 1989: 162). Although they are frequently assumed to have functioned in hunting technologies, there is neither archaeological nor ethnographic confirmation that all geometrics were used in this way (Clark 1987; Clarke 1976; see FIGURE 1).

The shape of the backing is the primary morphological characteristic differentiating Levantine (and other) microlith types. However, the backed portion was probably not the utilized edge, but served to facilitate hafting. As variations in backing only affect the hafted edge, it is likely that they served primarily to permit a geometric to be inserted into a pre-existing haft — often with other, already mounted microliths. Given the greater labour investment in haft manufacture relative to microlith production, hafts probably were curated artefacts and microliths more disposable; geometrics were altered to fit hafts rather than the other way around. It often would have been necessary to trim the backs of geometrics to fit into hafts during compound tool manufacture and into spaces left by broken microliths during maintenance. As shown schematically in FIGURE 8, such back trimming can readily transform one geometric type into another. In other words, while a geometric type, such as a trapeze, could have been the originally manufactured shape, it also could be produced by trimming a triangle, lunate or rectangle to fit into a compound tool. If so, geometric microlith types would simply represent variations on a basic microlith theme that were expediently altered to fit various haft configurations during tool manufacture and maintenance. It follows that these

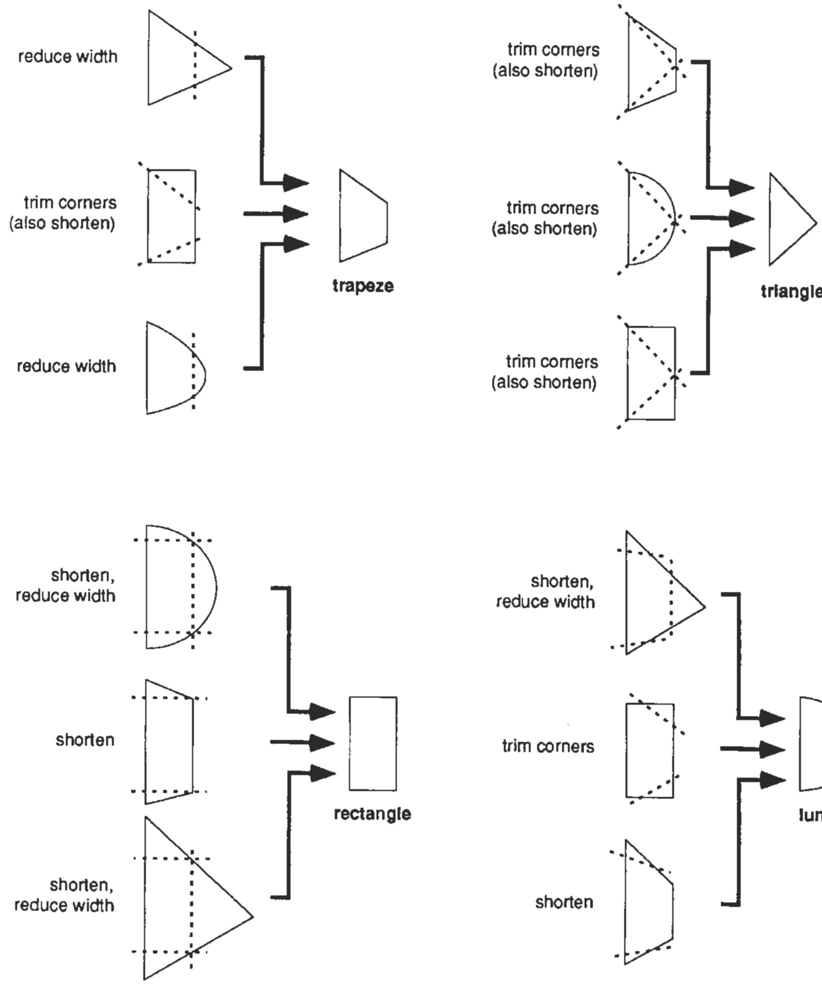


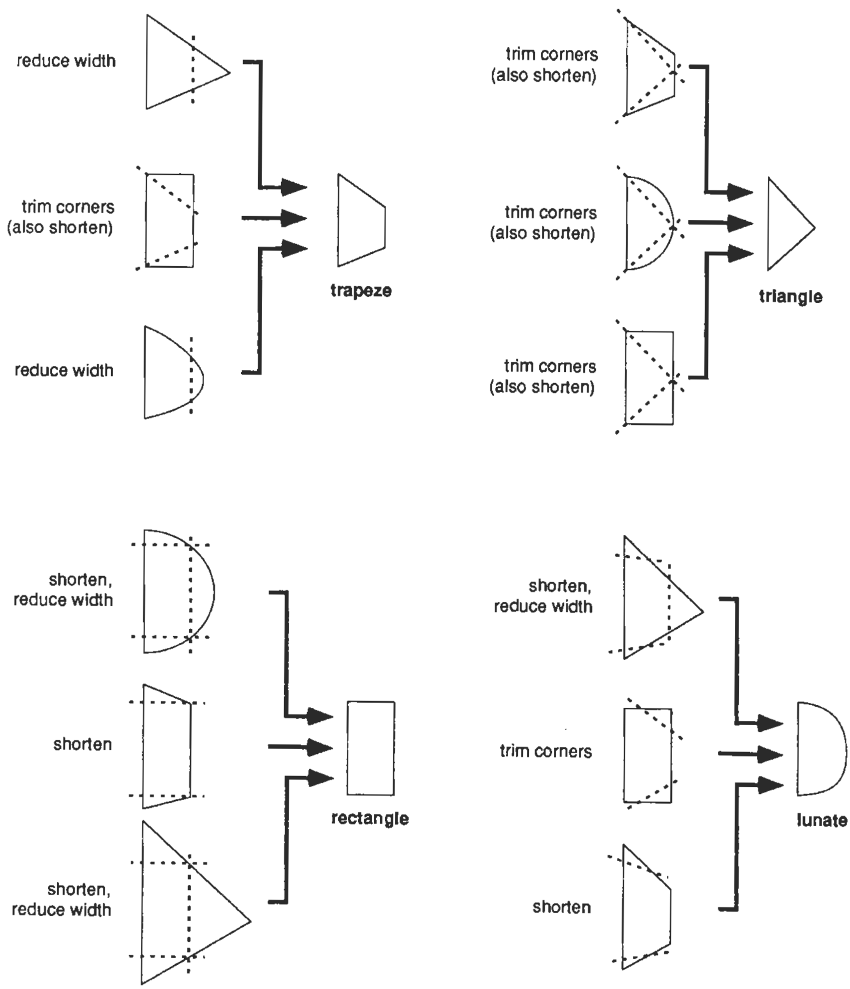
FIGURE 8. *Effects of trimming geometric microliths to fit in compound tools during manufacture or maintenance.*

tiny chipped stone artefacts all may have served a broadly equivalent range of functions as the working edges of a variety of composite artefacts (e.g. see FIGURE 1 and Clarke 1976).

If, on the other hand, geometric types represent morphologically discrete tools with distinct stylistic or functional validity, other aspects of artefact form should reflect this. That is, morphological features other than the backed edge should show a pattern of discrete variability for each type. Except for length and width, there are little in the way of quantitative data on geometric morphology currently available. Length represents the extent of cutting edge available, while width affects the depth to which microliths could be inserted into a haft. If different microlith classes served distinct functions, or represented styles associated with particular ethnic groups, it might be expected that their cutting edges and/or the haft in which they were set also would differ. On the other hand, if geometrics represent a generalized form that served numerous needs and back configuration is a response to idiosyncratic circumstances of tool manufacture and maintenance, different types would be expected to display similar ranges of variation with respect to edge length and hafting depth.

Comparisons of lengths and widths for lunates and the combined group of trapezes and rectangles[3] from Epipalaeolithic assemblages are shown in FIGURES 9 & 10. All three geometric types occur in varying frequencies

3 Reported metric data for trapezes and rectangles are often combined in the available literature.



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3 Reported metric data for trapezes and rectangles are often combined in the available literature.

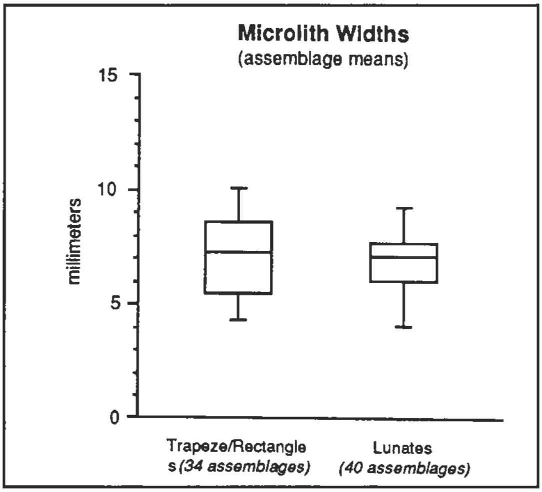

FIGURE 9. *Comparison of widths for trapeze/rectangles and lunates. (Data from Byrd 1989; Byrd & Rollefson 1984; Gilead & Marder 1989; Goring-Morris 1987; Marks & Larson 1977; Olszewski 1986b.)*

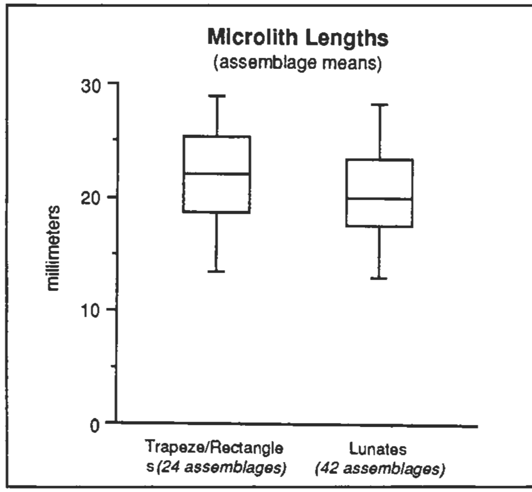

FIGURE 10. *Comparison of lengths for trapeze/rectangles and lunates. (Data from Byrd 1989; Byrd & Rollefson 1984; Goring-Morris 1987; Marks & Larson 1977; Olszewski 1986a; Valla 1984.)*

throughout much of the Levantine Epipalaeolithic, permitting this comparison to cross-cut traditional, typologically based, cultural and temporal boundaries (i.e. Natufian = lunate and Geometric Kebaran = trapeze/rectangles).

The mean widths of trapeze/rectangles and lunates differ only slightly (7·20 mm *vs* 6·89 mm) and the range of width values are virtually identical for these two types[4] (FIGURE 9). A Wilcoxon rank-sum test indicates no significant difference in width between the two types at $\alpha = 0{\cdot}05$ ($z = 0{\cdot}82$, $p = 0{\cdot}2061$).

The combined mean lengths of trapeze/rectangles and lunates differ only a little more than do widths (21·97 mm *vs* 20·38 mm), and there is, again, complete overlap in the distributions (FIGURE 10). A Wilcoxon rank-sum test verifies that the difference in length between these types is not significant at $\alpha = {\cdot}05$ ($z = 1{\cdot}53$, $p = 0{\cdot}0630$).

Discussion

The most distinctive feature of microlith morphology for archaeological typologists, the configuration of the backed edge, would almost certainly have been obscured during use of the artefact by the haft and any mastic used for mounting. This would tend to rule out intentional or assertive style (*sensu* Wiessner 1983) as a determinant of microlith shape. Morphological variability in microliths could incorporate cultural differences in the form of unintentional variation among different social groups, termed 'isochrestic variability' by Sackett (1982). However, this information may be difficult to extract if microliths exhibit continuous morphological variability, and if much of this variability is in fact a response to variation in raw material size and availability, the point(s) in the microlith manufacturing process represented by the discarded lithics at a site, and to idiosyncratic circumstances of compound tool manufacture and maintenance.

Taken together, these considerations suggest that the ability of microlith types to differentiate social groups needs to be critically re-evaluated. Large, well-dated assemblages, in which one form of microlith is overwhelmingly predominant, should be least affected by the model and data presented here. On the other hand, cases in which relatively subtle variations in microlith morphology or minor differences in the frequency of morphological types are used as markers of ethnic identity (e.g. Henry 1989: 156–77), are potentially problematic. Especially questionable are small assemblages for which cultural affiliations are judged on the morphology of a few microliths.

4 Only one measurement for triangles (a combination of triangles and trapeze/rectangles) was available with a mean width of 9·2 mm (Marks & Larson 1977).

A related problem is the use of morphological variability in microliths to date Epipalaeolithic sites. Although radiocarbon dates are available for a number of Levantine Epipalaeolithic sites, they are lacking at many more where temporal assignment often must rely on the nature of lithic assemblages. Dating a site solely on the basis of a small collection of microliths should be viewed with a healthy dose of scepticism.

Nevertheless, the model for microlith technology we propose offers an opportunity to examine other aspects of these late Pleistocene forager societies. For example, Mushabian sites may represent locales of microlith manufacture and compound tool manufacture. Such activities are more likely to have taken place in areas of greater raw material availability and at times of reduced mobility. Characteristic lithic residues would include the arched backed and scalene bladelets, and the high frequencies of microburin debitage (microburins and La Mouillah points) that typify this industry. On the other hand, the Geometric Kebaran, with high frequencies of geometric microliths and low microburin frequencies, may represent sites at which compound tool maintenance took place under conditions of greater settlement mobility. We hope further to test such interpretations with more detailed study of lithic and related data from Levantine Epipalaeolithic sites.

Conclusions

The underlying assumptions of traditional interpretations of Levantine Epipalaeolithic chipped stone industries are that:

1. morphological variability in microliths results from the production of discrete, predetermined microlith forms;
2. assemblage variability is due to culturally determined preferences for particular forms by ethnic groups that share a common heritage of lithic production and use.

However, because these interpretations are based on the definition and subsequent recognition of static and discrete ideal types, they tend to obscure the dynamic aspects of both lithic technology and resulting morphology. Also, because frequencies of morphological types are seen primarily as cultural and temporal markers, traditional typologies are inherently limited in their ability to address issues beyond that of time and space.

The models proposed here provide an alternative explanation for morphological variability in chipped stone industries of late-Pleistocene hunter/gatherers, not only in the Levant, but throughout the western Old World. Rather than comprising a suite of static, predetermined types, we see microlith form as dynamically responding to varying circumstances of raw material acquisition, manufacture, use and discard during the use-lives of these artefacts. We also emphasize that, as part of compound tools, microliths had to interact coherently with other artefacts, including hafts of bone, antler, wood or other materials; other microliths; and mastic needed to hold these different elements together. Even though it is widely recognized that microliths were part of compound tools, treatment of the potential effects of tool manufacture and maintenance on their morphology is generally lacking.

As archaeologists, our data are generally limited to the static, material residues of past human behaviour. This, and the tendency to generalize from the experience of our own industrialized technology (Barton 1991), often make it difficult to visualize the dynamic way in which items of material culture participate in living behavioural systems. While emphasizing the continuous aspects of lithic form and its relation to reduction technology may not solve all the problems we face in reconstructing and explaining cultural processes during the Epipalaeolithic, we suggest that it reflects reality more accurately than does the idealized, traditional typological orientation commonly used.

Although the widely used microlith typologies are based on morphological features (primarily backing) that may be unrelated to function or style, and may provide little information about social structure or the ages of sites, decades of dedicated research need not be discarded or ignored. If one can go beyond the interpretations associated with traditional systematics, these very same types can provide valuable information about other aspects of prehistoric life, such as lithic manufacture, resource availability and means of acquisition and patterns of mobility. We believe that this alternative model will prove a fruitful approach for understanding prehistoric Pleistocene and Holocene foragers, and hope that it will stimulate further discussion about making inferences from the chipped stone artefacts that make up the overwhelming bulk of the archaeological record.

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References

BAMFORTH, D.B. 1986. Technological efficiency and tool curation. *American Antiquity* 51: 38–50.

1991. Technological organization and hunter–gatherer land use: a California example, *American Antiquity* 56: 216–34.

BARTON, C.M. 1990. Beyond style and function: a view from the Middle Paleolithic, *American Anthropologist* 92: 57–72.

1991. Retouched tools: fact or fiction? Paradigms for interpreting chipped stone, in Clark (1991): 143–63.

BAR-YOSEF, O. 1991. Stone tools and social context in Levantine prehistory. in Clark (1991): 371–95.

BAR-YOSEF, O. & A.N. GORING-MORRIS. 1977. Geometric Kebaran A occurrences. in Bar-Yosef & Phillips (1977): 115–48.

BAR-YOSEF, O. & J.L. PHILLIPS (ed.). 1977. *Prehistoric investigation in Gebel Maghara, northern Sinai* Jerusalem: Hebrew University, Qedem 7. Monographs of the Institute of Archaeology.

BAR-YOSEF, O. & F.R. VALLA. 1979. L'évolution du Natoufien: nouvelles suggestions, *Paléorient* 5: 145–52.

BORDES, F. 1957. La signification du microburin dans le Paléolithique supérieur, *L'Anthropologie* 61: 578–82.

BYRD, B.F. 1987. Beidha and the Natufian: variability in Levantine settlement and subsistence. (Ph.D dissertation, University of Arizona, Tucson (AZ).) Ann Arbor (MI): University Microfilms.

1989. *The Natufian encampment at Beidha: Late Pleistocene adaptation in the southern Levant.* Aarhus: Aarhus University Press. Jutland Archaeological Society Publication 23: 1.

BYRD, B.F. & G.O. ROLLEFSON. 1984. Natufian occupation in the Wadi el Hasa, Southern Jordan, *Annual of the Department of Antiquities of Jordan* 28: 143–50.

CLARK, G.A. 1987. From the Mousterian to the metal ages: long-term change in the human diet of Cantabrian Spain, in O. Soffer (ed.), *The Pleistocene Old World: regional perspectives*: 293–316. New York (NY): Plenum.

1991. (Ed.). *Perspectives on the past: theoretical biases in Mediterranean hunter–gatherer research.* Philadelphia (PA): University of Pennsylvania Press.

CLARK, G.A. & J.M. LINDLY. 1991. On paradigmatic biases and Palaeolithic research traditions, *Current Anthropology* 32: 577–87.

CLARKE, D.L. 1976. Mesolithic Europe: the economic basis, in G.de G. Sieveking *et al.* (ed.), *Problems in economic and social archaeology*: 449–81. London: Duckworth.

COINMAN, N.R. 1990. Rethinking the Levantine Upper Paleolithic. (Ph.D dissertation, Arizona State University, Tempe (AZ).) Ann Arbor (MI): University Microfilms.

DIBBLE, H.L. 1987. The interpretation of Middle Paleolithic scraper morphology, *American Antiquity* 52: 109–17.

EDWARDS, P.C. 1987. Late Pleistocene occupation in Wadi al-Hammeh, Jordan Valley. (Ph.D dissertation, University of Sydney.)

GILEAD, I. & O. MARDER. 1989. Geometric Kebaran sites in Nahal Rut area, western Negev, Israel, *Paléorient* 15: 123–37.

GORING-MORRIS, A.N. 1987. *At the edge: Terminal Pleistocene hunter–gatherers in the Negev and Sinai.* Oxford: British Archaeological Reports. International series S361.

GORING-MORRIS, A.N. & U. AVNER. 1985. An Epipaleolithic occurrence in Eastern Sinai, Haj I, and some observations on the use of the microburin technique, *Mitekufat Haeven* 19: 58–65.

HENRY, D.O. 1973. The Natufian of Palestine: its material culture and ecology. (Ph.D dissertation, Southern Methodist University, Dallas (TX).) Ann Arbor (MI): University Microfilms.

1974. The utilization of the microburin technique in the Levant, *Paléorient* 2: 389–98.

1989. *From foraging to agriculture: the Levant at the end of the Ice Age.* Philadelphia (PA): University of Pennsylvania Press.

HOURS, F. 1974. Remarques sur l'utilisation de liste-types pour l'étude du Paléolithique supérieur et de l'Epipaléolithique du Levant, *Paléorient* 2: 3–18.

JELINEK, A.J. 1976. Form, function, and style in lithic analysis, in C.E. Cleland (ed.), *Cultural change and continuity*: 19–35. New York (NY): Academic Press.

KUHN, S.L. 1991. 'Unpacking' reduction: lithic raw material economy in the Mousterian of west–central Italy, *Journal of Anthropological Archaeology* 10: 76–106.

MARKS, A. E. & P.A. LARSON, JR. 1977. Test excavations at the Natufian site of Rosh Horesha, in A.E. Marks (ed.), *Prehistory and paleoenvironments in the Central Negev, Israel* II: 91–232. Dallas (TX): SMU Press.

MCCORRISTON, J. & F. HOLE. 1991. The ecology of seasonal stress and the origins of agriculture in the Near East, *American Anthropologist* 93: 46–69.

MOORE, A.M.T. & G.C. HILLMAN. 1992. The Pleistocene to Holocene transition and human economy in southwest Asia: the impact of the Younger Dryas, *American Antiquity* 57: 482–94.

OLSZEWSKI, D.I. 1986a. A reassessment of average lunate length as a chronological marker, *Paléorient* 12: 39–44.

1986b. *The North Syrian Late Epipaleolithic.* Oxford: British Archaeological Reports. International series S309.

1993a. Subsistence ecology in the Mediterranean forest: implications for the origin of cultivation in the Epipaleolithic southern Levant, *American Anthropologist* 95: 420–35.

1993b. Zarzian microliths from Warwasi rockshelter, Iran: scalene triangles as arrow components, in G. Larsen-Peterkin *et al.* (ed.), *Hunting and animal exploitation in the later Paleolithic and Mesolithic of Eurasia: 199–205.* Washington (DC): American Anthropological Association. Archaeological Papers 4.

PHILLIPS, J.L. & E. MINTZ. 1977. The Mushabian, in Bar-Yosef & Phillips (ed.): 149–83.

SACKETT, J.R. 1982. Approaches to style in lithic archaeology, *Journal of Anthropological Archaeology* 1: 59–112.

TIXIER, J. 1974. Glossary for the description of stone tools with special reference to the Epipaleolithic of the Maghreb, *Newsletter of Lithic Technology*: Special Publication 1.

VALLA, F.R. 1984. *Les industries de silex de Mallaha (Eynan).* Paris: Association Paléorient. Mémoires et Travaux du Centre de Recherche Français de Jérusalem 3.

WIESSNER, P. 1983. Style and social information in Kalahari San projectile points, *American Antiquity* 48: 253–76.