Interpreting Variability through Multiple Methodologies: Form, Function and Technology of Microliths

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ABSTRACT

The reason for material culture’s morphological variability is one of the most fundamental debates in archaeological studies. These debates factor strongly into Levantine Epipalaeolithic research, where the morphological variability of microlithic tools has been interpreted to represent distinct cultural or ethnic communities. Understanding the functional and technological aspects of microlith variability will greatly contribute to our understanding of how microlithic tools act as both functional artifacts and carriers of symbolic loads. My research addresses this question through the use of multiple methodologies, including analysis of retouching sequences, use-wear analysis, morphometrics, and typological studies. This research seeks to gain understanding of the transformative processes that are undertaken by tools over their life-history, addressing the diversity in Middle Epipalaeolithic material culture.

The driving force behind variability in lithic form has long been a topic of debate between archaeologists (Binford and Binford 1969; Bisson 2000; Bordes 1961; Dibble and Rolland 1992; Dibble 1984). Scholars have hypothesized that tool form is the result of ethnic identity (Bordes 1961; Bordes and de Sonneville-Bordes 1970), functional requirements (Binford and Binford 1969), or technological sequences of production (Dibble and Rolland 1992). These debates factor strongly into Levantine Epipalaeolithic research, where the diachronic and regional morphological variability of microlithic tools has been interpreted to represent distinct cultural or ethnic communities (Bar-Yosef 1970; Goring-Morris 1987; Henry 1995). Moving beyond these ethnic interpretations, exploring the functional and technological aspects of microlith variability will greatly contribute to our understanding of how microlithic tools act as both functional artifacts and carriers of symbolic information.
This paper discusses my prospective research that addresses the underlying meaning of microlith variability during the Epipalaeolithic through the use of multiple methodologies to analyze different types of variation within stone tools. Using the variables of morphology, function and technological production, the three primary hypotheses driving my research are:

1. Geometric microliths are over-engineered, suggesting that their morphology is more complex than needed for their function.
2. Different forms of geometric microliths will have overlapping functions, suggesting that function is not the driving force behind variation in form.
3. Each site will show distinct differences in technological production, suggesting that lithics were produced within ‘learning communities’ (Wenger 1998).

If all three of these hypotheses are proven during the course of analysis, I suggest that geometric microliths are carriers of symbolic loads during the Middle Epipalaeolithic, produced in communities of practice in which information and learning is shared between members.

The Epipalaeolithic Period

The Epipalaeolithic period took place during the transition from the Late Pleistocene to the Early Holocene in the Levant and is divided into three phases: the Early, the Middle and the Late. The archaeological record suggests that this period consisted of hunter-gatherer communities using microlithic tools and is characterized by variability in microlith types, both regionally and diachronically (Al-Nahar 2000; Bar-Yosef 1970; Goring-Morris 1987; Goring-Morris and Belfer-Cohen 1998; Henry 1995). Across time, the microliths move from non-geometric forms in the Early Epipalaeolithic to geometric microliths such as trapezoids and rectangles in the Middle Epipalaeolithic and finally geometric microliths in the form of lunates in the Late Epipalaeolithic. There is a wide diversity of microlith form during the Epipalaeolithic with regional distinctions in microlith shape during each of the three periods. My research focuses specifically on the geometric microlith forms of the Middle Epipalaeolithic, where trapezoidal and rectangular forms dominate the assemblages.

Active debates between scholars have tried to identify the reason for the variability seen in Epipalaeolithic microlith assemblages (for example see Barton and Neeley 1996; Clark 1996; Goring-Morris 1996; Goring-Morris, et al. 1996; Henry 1996; Neeley and Barton 1994; Phillips 1996). Early interpretations suggest that boundaries between microlith types represent boundaries between people and that different forms of tools are the result of different ethnic or cultural
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groups (Bar-Yosef 1970; Goring-Morris and Belfer-Cohen 1998; Henry 1995). These theories suggest that our typological classifications of microlith types represent meaningful distinctions between different groups on the Epipalaeolithic landscape. The interpretation that variability in stone tool form is indicative of ethnic group identity has been questioned by some recent scholars who highlight the inherent bias in typological analysis (Neeley and Barton 1994; Olszewski 2001; Olszewski 2006; Pirie 2004). A few studies have attempted to move beyond solely typological analysis of Epipalaeolithic stone tools by addressing stone tool function (Richter 2007; Tomenchuk 1983; Tomenchuk 1985). The incorporation of functional data with technological information will contribute to this discussion.

The question of why Epipalaeolithic microlith form changes across time and space links into larger discussions of how people interact with material culture. The people of the Epipalaeolithic are modern humans practicing a hunting and gathering subsistence pattern. Because this period precedes the Neolithic, many studies examine features of the Epipalaeolithic looking for initial signs of Neolithic behaviours (Bar-Yosef and Belfer-Cohen 1989; Grosman and Belfer-Cohen 1999; Hillman 2000; Verhoeven 2004). Thus, the Epipalaeolithic is viewed as a step towards agriculture. However, this teleological framework suggests that the Epipalaeolithic people were actively pushing themselves towards domestication. In contrast to viewing it as a ‘transitional’ period, the Epipalaeolithic needs to be viewed on its own merit (example Boyd 2006). Increasing diversity is a dominant feature of the Epipalaeolithic. Understanding this diversity and change in material culture, not as an evolutionary step towards agriculture, but as a feature of modern human behaviour, is an important step towards understanding interactions between people and objects.

Archaeological Sites

I have chosen three sites to address the question of microlith variability, the site of ‘Uyun al-Hammâm, located in northern Jordan, the site of Kharaneh IV, located in the Eastern Desert and the site of Wadi Mataha, located in southern Jordan. All three of these sites date to the Middle Epipalaeolithic period making them roughly contemporaneous.

As mentioned above, the site of ‘Uyun al-Hammâm is located in Northern Jordan. University of Toronto excavations, conducted by the Wadi Ziqlab Project, have been ongoing at this site since 2000. The site is located near a permanent water source and has abundant raw materials in the immediate vicinity (Maher 2005). During the course of excavations we uncovered at least nine individuals interned in a variety of burial positions including extended, flexed, multiple burials and secondary contexts. This number of Middle Epipalaeolithic burials has
not been found on any other sites from this period, making the find at ‘Uyun al-Hammâm unique for the Middle Epipalaeolithic (Maher 2006). The retouched lithic assemblage is composed of classic Middle Epipalaeolithic tools, including trapeze-rectangle microliths (Maher 2005). Preliminary analysis of the tool assemblage suggests that the geometric microliths are highly standardized.

The site of Kharaneh IV is located in the Eastern Desert of Jordan. Current excavations are being conducted at the site by the Epipalaeolithic Foragers in Azraq Project (Leverhulme Centre for Human Evolutionary Studies, University of Cambridge). Kharaneh IV is an exceptionally large Epipalaeolithic site with an extremely high density of lithic artifacts on the surface. Occupations at the site range from the Early Epipalaeolithic through to the Middle Epipalaeolithic (Muheisen 1988a). Early excavations conducted by Muheisen (1988a; 1988b) suggested that the Middle Epipalaeolithic layers contained hearths, living surfaces and postholes; all exceptionally rare features from this time period. Our 2009 excavations uncovered two additional hearths, possible postholes, and compact surfaces with in situ artifacts, corroborating the initial findings. Preliminary analysis suggests that there is much greater diversity in geometric microlith form in the Middle Epipalaeolithic deposits at Kharaneh IV then at ‘Uyun al-Hammâm. Although there are classic trapeze-rectangles, the assemblage is also composed of asymmetrical trapezoids, lunates, triangles, and a variety of other geometric forms (Muheisen and Wada 1995).

The final site I am including in this project is the site of Wadi Mataha, located close to the site of Petra in Southern Jordan on a slope leading up to sandstone cliffs. The site has multiple components, dating from the Middle Epipalaeolithic through the Early and Late Natufian (Janetski and Chazan 2001). The Middle Epipalaeolithic component is located on the upper slope of the site. The Middle Epipalaeolithic deposits at this site contained a human burial, as well as a wealth of lithic and faunal material (Stock, et al. 2005). These three sites represent three different geographic zones, each with different Middle Epipalaeolithic tool assemblages. Therefore, the use of these three sites provides a good representation of the synchronic variability within the Middle Epipalaeolithic.

Methodology

For my dissertation research I am using multiples methodologies to address the issue of variability in these archaeological assemblages. This includes the morphology, technological sequence of production, and the function of microliths. Through using these multiple methods, different levels of variability within a single tool can be explored.
My approach to the retouched sequencing of Epipalaeolithic microliths is adapted from the innovative work by Marder et al. (2006). In this study, the authors reconstruct the chaîne opératoire of the tool itself, rather than the actions leading up to the creation of the tool. By analyzing the overlap of retouch scars on microlith backing, the authors were able to determine the series of removals used to create each microlith shape. This focuses on the individual process used to create each piece and reconstructs the actions that produced the tool. Understanding the sequence of retouch follows the transition of the tool from a blank to the geometric microlith (Figure 1). This style of analysis highlights the individual differences and similarities of single tools rather than producing a general knapping sequence for a site. I hope that through the analysis of the microliths at each site I will be able to find patterns within each of the assemblages that highlight different structures and behaviours between these communities.

My research includes a use-wear component in order to address the functional uses of the geometric microliths. The analytical technique of use-wear analysis has traditionally relied on qualitative observations to identify wear patterns microscopically, either at high or low magnifications. Low powered microscopy highlights microfractures and damages on a tool’s edge while high-powered microscopy identifies polishes and striations (Hayden 1979; Keeley 1980). The combination of low-powered and high-powered microscopy is integral to interpreting microwear patterns on a tool’s surface provided a more robust analysis of wear features (Grace 1989; Grace 1996).

One critique of qualitative use-wear analysis is that it leaves open the possibility for error and conflict of interpretation between individuals. Blind tests have been conducted by numerous researchers, with variable degrees of reliability and reproducibility (Odell and Odell-Vereecken 1980; Rots, et al. 2006). Some of
Figure 2: Image taken with the Alicona microscope of experimental tool (unidirectional whittling of oak with the ventral surface towards the worked material for 30 minutes).

Figure 3: Image of microlith surface using the Alicona InfiniteFocus microscope.

these tests have produced very positive results, while others have shown that there is a high degree of variability between different use-wear analyst’s interpretations of microwear. As a result, the interpretations of different researchers can greatly
influence and impact the research results. This causes difficulties when attempting to compare results from assemblages analyzed by different researchers.

In addition to qualitative analysis, recent studies have been taking a quantitative approach to lithic microwear analysis, using new technologies that generate measurements of surface topography, polish brightness and profile paths across surface features (Evans and Donahue 2008; González-Urquijo and Ibáñez-Estévez 2003; Lerner, et al. 2007; Stemp and Stemp 2001; Stemp and Stemp 2003). For my research I am using an Alicona InfiniteFocus microscope to quantify wear patterns on the microlith assemblages. Quantitative analysis allows for greater comparability between tools, assemblages, and between the results of different researchers. In combination with traditional qualitative research, quantitative analysis can provide a robust understanding of prehistoric tool function.

Alicona InfiniteFocus Microscope generates three-dimensional images of surface topography (Figure 2), allowing for surface roughness measurements, profile path measurements and visual details of topographic features (Figure 3, Table 1). The detailed resolution of images and the numerical data generated from this microscope allows for cross comparison of surface features between different tools. The primary feature of the Infinite Focus microscope is that it analyzes the object in three dimensions, giving output with x, y, and z coordinates. Due to the small size of microliths, each piece can be completely scanned to render the three-dimensional form of the tool (Figure 4).

The Alicona microscope also allows for the calculation of surface roughness. From the surface topography numerous roughness statistics can be calculated including the average height of the selected area, average roughness, the maximum peak, and the maximum valley depth. These results can be compared between different tools to understand the variability and similarities in use-wear patterns. Research by Evans and Donahue (2008) using a Laser

Table 1: Roughness calculations for surface area indicated in Figure 3.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sa</td>
<td>21.783µm</td>
<td>Average height of selected area</td>
<td></td>
</tr>
<tr>
<td>Sq</td>
<td>25.753µm</td>
<td>Root-mean-square height of selected area</td>
<td></td>
</tr>
<tr>
<td>Sp</td>
<td>39.896µm</td>
<td>Maximum peak height of selected area</td>
<td></td>
</tr>
<tr>
<td>Sv</td>
<td>56.11µm</td>
<td>Maximum valley depth of selected area</td>
<td></td>
</tr>
<tr>
<td>Sz</td>
<td>96.006µm</td>
<td>Maximum height of selected area</td>
<td></td>
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</tbody>
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Figure 4: Three-dimensional image of microlith from Kharaneh IV in real colour and pseudo-colour. Magnification 5x, vertical resolution at 2 um.

Scanning confocal microscope suggests that different worked materials produce different average roughness calculations. The calculation of average surface roughness using the Alicona microscope will help to further develop this quantitative research on lithic use-wear.

Conclusions

Previous research on Epipalaeolithic lithic assemblages has focused on how social boundaries are expressed through the style and form of microliths. In contrast, my research looks to understand the integration of form and function in geometric microliths through the analysis of multiple dimensions of tool variability. All aspects of geometric microliths will be analyzed and considered, including the form, the technological production and the function of the tool (Figure 5). Typological analysis, technological analysis of retouch sequencing, qualitative and quantitative aspects of use-wear analysis will be combined to understand multiple levels of variability. This will help understand the transformative processes that are undertaken by microliths over their life-history, addressing the diversity in Middle Epipalaeolithic material culture.
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Figure 5: Location of low-powered use-wear images and Alicona images on a microlith from ‘Uyun al Hammâm. Figure 1 shows the retouch sequencing for this microlith.

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References

Al-Nahar, Maysoon

Bar-Yosef, Ofer

Bar-Yosef, Ofer, and Anna Belfer-Cohen
Barton, C. Michael, and Michael Neeley
Binford, Sally, and Lewis Binford
Bisson, Michael
Bordes, Francois
Bordes, Francois, and Denise de Sonneville-Bordes
Boyce, Brian
Clark, Geoffrey
Dibble, H., and N Rolland
Dibble, Harold L.
Evans, Adrian A., and Randolph E. Donahue
González-Urquijo, Jesús Emilio, and Juan José Ibáñez-Estévez
Goring-Morris, Adrian Nigel
Goring-Morris, Adrian Nigel, and Anna Belfer-Cohen
Goring-Morris, Adrian Nigel, et al.
Grace, Roger
Grosman, Leore, and Anna Belfer-Cohen
Hayden, Brian
Henry, Donald O.

Hillman, Gordon C.

Janetski, Joel, and Michael Chazan

Keeley, Lawrence

Lerner, Harry, et al.

Maher, Lisa


Marder, Ofer, Jacques Pelegrin, Boris Valentin, and Francois Valla

Muheisen, Mujahed


Muheisen, Mujahed, and H Wada

Neeley, Michael, and C. Michael Barton

Odell, George, and Frieda Odell-Vereeeken

Olszewski, Deborah


Phillips, James

Pirie, Anne

Richter, Tobias

Rots, Veerle, Louis Pirnay, Philippe Pirson, and Odette Baudoux

Stemp, W. James and Michael Stemp
Stock, Jay T., Susan K. Pfeiffer, Michael Chazan, and Joel Janetski
Tomenchuk, John
1985. The Development of a Wholly Parametric Use-Wear Methodology and its Applications to Two Selected Samples of Epipaleolithic Chipped Stone Tools from Hayonim Cave, Israel, University of Toronto.
Verhoeven, Marc
Wenger, Etienne

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