Edited by **Nicholas J. Conard and Anne Delagnes**

Settlement Dynamics of the Middle Paleolithic and Middle Stone Age

Volume IV

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Chapter 7 | Changes in Land Use and Occupation Intensity at the Onset of the Middle Paleolithic? A View from Tabun Cave, Israel

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Abstract. *Considerable attention has been given to occupation intensity and settlement patterns in the Levantine Middle Paleolithic (Meignen et al. 2005; Hovers 2001; Marks and Friedel 1977; and others) but we still have relatively little understanding of long term changes in the ways hominids used the landscape or particular sites during earlier periods. Because its deep deposits document considerable spans of time for both periods, Tabun Cave in Israel is an ideal context to investigate site use and mobility in the late Lower Paleolithic and to contrast it with the succeeding Middle Paleolithic.*

This study compares retouch frequency with artifact density throughout the Tabun stratigraphy, a simple method for evaluating relative levels of occupational intensity or duration. The Levantine Mousterian beds (I-IX) at Tabun follow the typical negative relationship between these two variables, consistent with Middle and Upper Paleolithic sites throughout Europe (Riel-Salvatore et al. 2008; Riel-Salvatore and Barton 2004; Kuhn 2004). The earlier cultural deposits of Units XI-XIV display no relationship between these two variables. This change seems to occur precisely at the break between cultural periods, and does not appear to correspond to a shift in sediment accumulation rate. The lack of clear association between artifact density and retouch frequency in Units XI-XIV at Tabun could indicate that early Mousterian and pre-Mousterian populations used the site and its surrounding landscape in different ways.

Résumé. *Beaucoup d'attention déjà été portée sur l'intensité d'occupation et l'utilisation du territoire au Paléolithique moyen Levantin, mais nous n'avons que très peu d'informations sur ces comportements au Paléolithique ancien (Meignen et al. 2005; Hovers 2001; Marks and Friedel 1977 et autres). Les dépôts très importants de la grotte de Tabun en Israël forment un contexte idéal pour aborder la fonction du site et le comportement de mobilité au Paléolithique ancien tardif et au Paléolithique moyen.Cette étude compare la fréquence des objets retouchés avec la densité totale des artefacts pour toute la séquence stratigraphique de Tabun, une méthode simple*

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pour l'évaluation des niveaux d'intensité ou de la durée d'occupation. Le rapport entre ces deux variables dans les couches de Tabun rapportées au Moustérien levantin (unités I-IX) est négatif, ce qui est en accord avec les sites du Paléolithique moyen et supérieur en Europe (Riel-Salvatore et al. 2008; Riel-Salvatore and Barton 2004; Kuhn 2004). Les dépôts les plus anciens des unités XI-XIV ne révèlent par contre aucune relation entre ces deux variables. Ce changement semble se produire exactement à la rupture entre les deux périodes et ne semble pas correspondre à une diminution dans le rythme de sédimentation de la cavité. L'absence d'une claire association entre la densité d'artefacts et la fréquence des objets retouchés pour les unités XI-XIV à Tabun peut indiquer que les populations moustériennes et pré-moustériennes ont utilisé le site et le paysage alentour de façons différentes.

INTRODUCTION

Over the past decade, interest in mobility and settlement patterns has been growing continuously. This study attempts to read basic patterns of mobility and technological organization from a long sequence at a single site. In this sense, it is different from many settlement studies which attempt to link multiple sites within one region to fit into a larger pattern. Because of the length of the Tabun sequence, it documents patterns of behavior repeated over a long period of time. However, this picture is very coarse grained. It shows behavioral tendencies but not a configuration of a settlement system which corresponds to a particular interval of time. It must be contextualized through comparisons with other settlement studies performed in the region. This is simple for the Levantine Mousterian, which has received a great deal of attention on this subject (Meignen et al. 2005; Marks 1989; Marks and Friedel 1977; Hovers 2001; Wallace and Shea 2006), but less so for the earlier part of the sequence which has received much less interest. The pattern found at Tabun Cave does fit in comfortably

Fig. 1. Location of Tabun and some of the major Levantine Middle Paleolithic and Acheulo-Yabrudian sites nearby.

with studies focusing on settlement patterns in the Levantine Mousterian. The earlier deposits, corresponding to the Mugarhan tradition or Acheulo-Yabrudian complex, follow a very different pattern, suggesting that there was a fundamental change in mobility or land use between these periods.

A number of studies of both cave and rockshelter sites (Riel-Salvatore and Barton 2004; Kuhn 2004; Riel-Salvatore et al. 2008) have investigated changes in occupation intensity by examining the relationship between the frequency of retouched tools and artifact density. These studies consistently show an inverse relationship between density and tool frequency for Middle and Upper Paleolithic sites in Europe. This relationship represents a continuum between periods of greater intensity of site use and *in situ* core reduction producing high artifact density and low tool frequency, and periods with lower intensity of site use and little core reduction, resulting in high frequencies of retouched pieces but low overall density of finds. The study reported here utilizes data collected during Jelinek's excavations to investigate whether the patterns seen in Europe can be replicated at Tabun Cave. Results indicate that the upper units, corresponding to the Levantine Mousterian, follow the expected pattern but that the lower deposits do not exhibit any relationship between the two variables.

TABUN CAVE

Tabun Cave is located on the western flanks of Mount Carmel in Israel (figs. 1 and 2). Dorothy Garrod first began excavating the site in 1929 (Garrod and Bate 1937; Jelinek et al. 1973), exposing a cultural stratigraphy more than 24 m deep and span-

Fig. 2. Photo of the lower Wadi Mughara. Tabun is indicated with the arrow. Note the roof structure covering the chimney opening. Photo courtesy of Arthur Jelinek.

ning the Middle Paleolithic and latter part of the Lower Paleolithic. From 1967 to 1971, Arthur Jelinek excavated the site, recording the coordinates of every object greater than 2 cm and meticulously documenting very fine variation in sediments. Jelinek divided the stratigraphy into numbered beds, many of which are subdivided into sub-beds. Beds in turn are grouped into larger stratigraphic units (Table 1). Sources of sediments at the site fall into two categories. Gradual eolian infilling prevailed for much of the sequence, but there was a rapid shift to colluvial sedimentation when a chimney opened in the ceiling around Unit II (fig. 3). Thus, there was a significant shift in accumulation rate late in the sequence, well within the Mousterian deposits (which begin at Unit IX).

Tabun's deposits can be roughly divided into two major technological periods (which do not correspond with the shift in accumulation rate). The first corresponds with what Jelinek termed the Mugharan tradition and is now also known as the Acheulo-Yabrudian complex (Shimelmitz et al. 2011; Stiner et al. 2011; Zaider et al. 2005). Lithic assemblages are characterized by heavy scrapers with scaled retouch, as well as handaxes. Relative proportions of these artifacts divide the stratigraphic units into Acheulean, Yabrudian, or Amudian facies. The Amudian contains evidence for systematic production of small blades and Upper Paleolithic type tool forms (endscrapers and backed knives), in addition to the characteristic pieces that dominate the Acheulean and Yabrudian facies. Although the Acheulo-Yabrudian has been considered by many as part of the Lower Paleolithic (Jelinek 1982a; Zaidner et al. 2005; Gopher et al. 2005), some have begun considering it as part of the early Middle Paleolithic (Le Tensorer et al. 2001). Whatever the terminology used, the technological capacities of the hominins that manufactured the Acheulo-Yabrudian is clearly at a high level, equal or close to that of many Middle Paleolithic assemblages from Europe. Yabrudian scrapers, for example, closely resemble much later artifacts from the Quina Mousterian of France. Yabrudian and allied assemblages are known from other sites in the Mediterranean coast as well as inland deserts (Copeland and Hours 1983; Zaidner et al. 2005; Le Tensorer et al. 2001), but are always found either in cave/rockshelter settings or associated with permanent springs.

Table 1. Jelinek's units and the corresponding bed numbers, cultural categories, and thermoluminescence dates (Jelinek 1982; Mercier and Valladas 2003).

Unit	Content	Beds	Mean Age (from TL)
I	C-type Mousterian	1-26	165 ± 16
II	C-type Mousterian	27-32	196 ± 21
III-VIII	Mixed C and D-type Mousterian	33-61	222 ± 27
IX	D-type Mousterian	62-69	256 ± 26
X	Transitional/Mixed	70-72	267 ± 22
XI	Acheulo-Yabrudian (incl. Amudian)	73-77	264 ± 28
XII	Acheulo-Yabrudian	78-80	324 ± 31
XIII	Acheulo-Yabrudian	81-85	302 ± 27
XIV	(late) Acheulean	90A-90J	

Fig. 3. Photo of the stratigraphy at Tabun. The upper line indicates the change in sedimentary regimes while the lower line (dotted) is the boundary between the Levantine Mousterian and the Acheulo-Yabrudian. Photo courtesy of Arthur Jelinek.

The second major sequence at Tabun is the Levantine Mousterian, based on Levallois reduction. This sequence includes the classic Tabun A, B, and C industries defined by Garrod (Garrod and Bate 1937). The oldest Mousterian assemblages, "Tabun D," contains many elongated Levallois points and a high frequency of prismatic and Levallois blades. The Levallois found in "Tabun C" layers is much more concentrated around broad Levallois points and centripetal flaking. "Tabun B" forms another category in the minds of some analysts, even though its higher frequencies of Levallois points and narrow flakes are often not as easily distinguishable (Jelinek 1982b). While many archaeologists still refer to Tabun B, C, or D, it is clear now that the distinctions between these units could represent slow transitions over time and might not signify discrete behavior changes. In any case, while many would lump Tabun B and C together, Tabun D is still generally considered to be technologically distinct. In Jelinek's sequence, Units I and II yielded Tabun C type industries, whereas Unit IX yielded the earlier D-type assemblages (see Table 1).

ARTIFACT DENSITY, TOOL FREQUENCY, AND OCCUPATION INTENSITY

This study relies on the density of lithic artifacts as the primary indicator of the intensity of hominid use of Tabun Cave. Artifact density is considered to be one of the primary indicators of occupational intensity in archaeological sites, although discard rates may vary among technological systems and activity sets. Thick accumulation of lithic materials, however, is generally always the result of core reduction, no matter the production system. Coupled with tool frequency we are able to examine the relative importance of core reduction in each assemblage, and the relative importance of tools, either those produced *in situ* or those abandoned from a mobile tool kit.

The difference in these signals relates to the mobility and provisioning strategies of those occupying the site. Provisioning strategies are the different ways mobile hunter-gatherers choose to equip themselves with stone resources (Kuhn 1994). In some situations, if they were planning on staying at a site for a longer period of time, for example, groups might choose to bring larger chunks of raw materials back to the site so that they could produce their lithic tools there. In other situations, they may have chosen to create their tools either at the place of raw material extraction or at another, earlier visited site. Kuhn (1992) calls this dichotomy the difference between provisioning places or individuals. Like the dichotomy between collectors and foragers created by Binford (1980), the distinction between provisioning places or individuals is a continuum, particularly when we consider the number of overlapping strategies encompassed in each archaeological layer.

Assessments of variation in density require considering how assemblage characteristics are related to other aspects of the archaeological and sedimentary records. In this study, the correlation between density (number of lithic artifacts per volume of sediment) and the proportion of blanks retouched across sedimentary beds is used as evidence of how intensively the site was used relative to the rate of sediment accumulation.

While the density of faunal remains or other cultural debris ideally should be considered in conjunction with lithic remains, it is more problematic due to the effects of other bone collectors and differential preservation. Faunal remains are very scarce in most of the area of Tabun excavated by Jelinek as a result of mechanical or chemical destruction of bone (Jelinek et al. 1973; Margaris 2000). Lithics, on the other hand, are always the result of human behavior (as long as the site is not located directly on a bed of raw material or the artifacts are not introduced into the site by water or gravity) and are not nearly as susceptible to processes of decay as are faunal remains. However, one cannot compare the densities of archaeological layers without considering what factors, both geological and cultural, played a part in creating the assemblage.

Because one computes density based on the volume of the sediment in which the artifacts are encased, the rate at which this sediment accumulated is central to drawing any larger inferences about artifact accumulation rates. Farrand (2001) states that the only way one can obtain a numerical rate of sediment accumulation is to have a long series of very accurate radiocarbon dates. Because of the antiquity of Paleolithic sites this is generally not possible, so one must rely to a large extent on relative assessments of accumulation rates. For example, Farrand points out that it is important to examine surfaces for clues about breaks in sediment deposition. This could be marked by the weathering of a surface (though there is unlikely to be pedogenesis in caves) and erosion of surfaces. Identification of a weathering surface can be achieved through visual observations while excavating, or through micromorphology (Macphail 1992). Micromorphology could also help to evaluate the rate of sediment accumulation.

At Tabun, Farrand found an erosional surface between Garrod's Layers C and D indicating that there was a gap in sediment accumulation between these periods. Furthermore, this also marks the transition from aeolian to colluvial mechanisms of sediment deposition. In addition, one should take care to understand the degree of erosion or other processes that may have removed sediments and/or artifacts from the site (Barton and Clark 1993). Tabun likely experienced sediment loss through its swallow hole cavities (Jelinek et al. 1973), although this probably would not have affected most of the sediment column excavated by Jelinek.

The artifacts themselves provide independent indications as to how the site was used and how hominids moved about the landscape. This study uses simple measures of retouch frequency and percentage of burned lithics as evidence of the contexts in which artifacts entered the site and of the activities of humans within the cave. The frequency of retouched artifacts in an archaeological layer, for example, is a measure of the degree of core reduction taking place at the site while burning frequency tells how often the site was (re)used as a campsite and how often fires were rekindled on old occupation surfaces (Stiner et al. 1995). Together, these measurements inform whether a site was provisioned and if it functioned commonly as a campsite.

When comparing artifact density with retouch frequency, patterns can become obscured by recycling behavior. Fortunately, recycling should have the opposite effect on assemblage formation due to mixing different provisioning strategies (Kuhn 2004). If recycling is the dominant process, retouch frequencies should show a positive relationship with artifact density, as there would be more opportunity to recycle artifacts where they were abundant. One could also potentially examine patina to determine whether artifacts had been recycled. However, this technique would only work in a situation where patination was common, and it also would only show recycling after significant gaps between abandonment events.

The temporal (and geological) scale of assemblages is another important variable. Many (if not most) of the archaeological layers utilized when comparing density and frequency of retouched tools do not represent single habitation events. This would not make a huge difference if the site was utilized in a consistent manner. However, if a group frequently changed the way it utilized the site so that each layer contained debris from multiple occupations, event-specific patterns could be obscured. The primary consequence would be that the strength of the association would change as one changed the scale of analysis. Thin archaeological layers, which represent shorter periods of time and perhaps even single events, could potentially send a clearer signal than layers which spanned a greater amount of time and sampled multiple occupations of different durations and intensities. On the other hand, thinner layers could also be subject to greater noise from post-depositional processes.

The continuum utilized by Kuhn (2004) and Riel-Salvatore and colleagues (2008; Riel-Salvatore and Barton 2005) does allow for the palimpsest of settlement patterns. Those assemblages which lie at each end of the continuum—high density and low retouch frequency or low density and high retouch frequency—show a clear signal where site utilization is more or less constant. The layers which fall into the middle, however, could encompass habitations of varying lengths, where different strategies of raw material provisioning and artifact production were used, or they could simply represent uniform occupations of moderate duration. This method of comparing density to tool frequency is therefore not a way of separating a static "forager" system from a "collector" system, but a way of organizing an otherwise mixed and variable set of signals from a dynamic system.

METHODS FOR CALCULATING ARTIFACT DENSITY AT TABUN CAVE

In order to calculate artifact density at Tabun, it was necessary to estimate the volume of the archaeological beds. Jelinek did not record sediment volumes of individual beds, and given the irregular contours of many layers this would have been nearly impossible in the field. The necessary calculations were derived from 3-D artifact coordinates using ArcGIS 9.2. The volume of each bed was computed by creating two surfaces, one based on the points at the top of the bed (those higher in elevation) and another based on the points at the bottom of the bed (those lower in elevation). These two surfaces were then subtracted and the difference used to estimate volume for the bed. The steps I used in creating the surfaces and estimating the volume were as follows:

1) For each bed, the cluster of artifact points was overlaid with a 25 cm polygonal array (a fishnet polygon). The bed was thus broken up into a series of 25 cm x 25 cm squares, each with a point at its centroid. Twenty-five cm was chosen as a size for the array because it was large enough, in most cases, to encompass at least two artifacts in every square (so that there would be max/min values for the elevation), but not so large that it overestimated volume.
2) Minimum and maximum values were attached to these centroids based on the elevation of artifacts located within each square. Therefore, while the midpoint of each square maintained an x and y coordinate based on its location in the array, it had two z-values representing the maximum and minimum elevation values for the artifacts within each box.
3) A spline algorithm was used to interpolate two surfaces, one using the minimum z-values, and the other using the maximum z-values. A spline interpolation algorithm was chosen as a surface creation method because unlike other interpolation methods, such as inverse distance weighing, it strives to produce smooth surfaces which more closely approximates the actual surface of the archaeological beds.
4) The surfaces were clipped to the extent of the artifacts using a convex polygon created for each bed.
5) Finally, these surfaces were subtracted and the values for all cells in a layer summed to create a measure of volume. This measurement can be converted into cubic meters by multiplying by the area of one cell (.01 x .01 cm).
6) Once this process had been tested sufficiently, it was automated using a graphical programming language in ArcGIS so that one only needed to enter the bed number and, seconds later, a volume measurement would be produced.

Artifact density was computed by dividing the number of coordinated artifacts (all lithics greater than 2 cm) in each bed by the volume. For the tool-to-flake ratio I included all flaked tools.

RESULTS: DENSITY AND RETOUCH FREQUENCY ACROSS THE TABUN SEQUENCE

When density is plotted against the tool-to-flake ratio across the entire Tabun sequence, some surprising patterns emerge. It is immediately apparent that there are two separate trends (fig. 4). Upon further exploration, each of these trends corresponded to the Levantine Mousterian and Acheulo-Yabrudian layers. The beds in Units I-IX, (which represent the Levantine Mousterian) display the negative relationship between artifact density and tool-to-flake ratio observed by researchers in other Middle and Upper Paleolithic sites (fig. 5). In contrast, the lower levels (Acheulo-Yabrudian) do not show the expected pattern (fig. 6). In these layers, frequencies of retouched pieces are uniformly relatively high but there is a great deal of variation in density. Moreover, there is no statistical or visual trend.

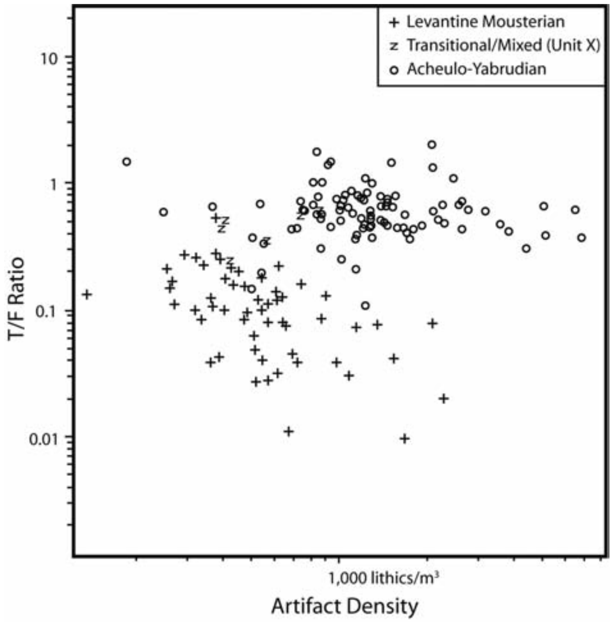


Fig. 4 (above). Tool-to-flake ratio plotted against artifact density for all beds in Tabun Cave. Note the two separate patterns exhibited. Density is expressed in lithics/m^3.

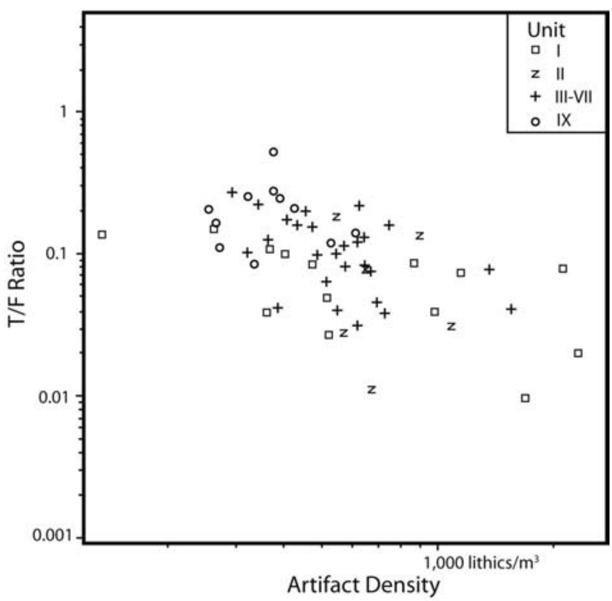


Fig. 5 (right). Tool-to-flake ratio plotted against artifact density for the Levantine Mousterian beds (Units I-IX in Tabun Cave). The negative correlation is significant ($r = -.3726$, $p < 0.01$, $df = 58$). Density is expressed in lithics/m^3.

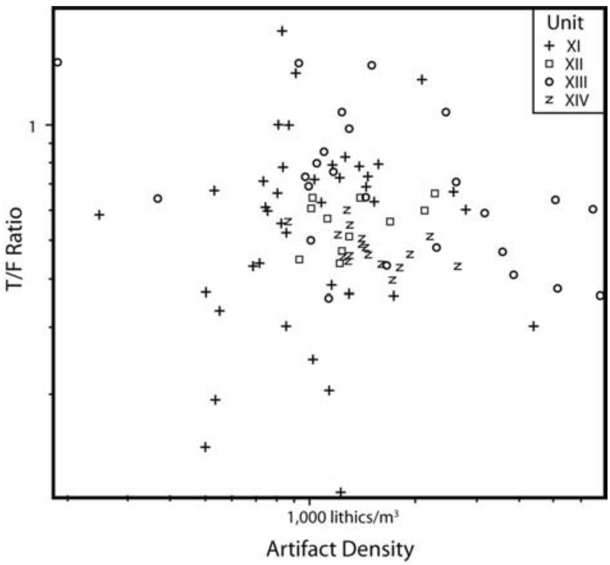


Fig. 6. Tool-to-flake ratio plotted against artifact density for the Acheulo-Yabrudian beds (Units XI-XIV in Tabun Cave). The correlation is not significant ($r = -.0487$, $p > 0.5$, $df = 93$). Density is expressed in lithics/m^3.

Within the Levantine Mousterian beds there is a significant correlation between tool-to-flake ratio and density ($r = -.3726$, $p < 0.01$, $df = 58$). A particularly interesting dimension of this relationship is that within only one of the units is there a significant correlation between these variables (Table 2). In other words, the linear relationship evident in figure 5 appears mainly as a contrast between the different Middle Paleolithic units. Moreover, the only significant intra-unit correlation is for Units III-VIII, which are geologically mixed and therefore do not give an accurate picture of site use. When the units for the Levantine Mousterian are examined together, they strengthen the linearity and the correlation becomes significant. The correlation remains significant even when the mixed units (Unit III-VIII) are not included ($r = -.3637$, $p < 0.05$, $df = 31$). Although statistically significant, this correlation is not particularly strong: that is, artifact density is not a very good predictor of frequency of

Unit	**r**	**df**	**Significant? α = .05**
I	-0.4865	13	
II	0.0084	5	
III-VIII	-0.4222	25	X
IX	-0.0886	9	
X	0.611	4	
XI	0.0029	38	
XII	0.4203	9	
XIII	-0.3565	25	
XIV	-0.458	15	

Table 2. Tabun Cave. r values for the correlation between density and tool-to-flake ratio for each archaeological unit.

retouched tools. On the other hand, given the absence of independent controls over varying rates of sediment accumulation, I expect the relationship to be a noisy one.

The position of the Levantine Mousterian units within this relationship is consistent with the findings presented by Meignen and colleagues (2005) regarding the changes between the earlier and later Mousterian in the Levant. They found that archaeological assemblages dating to the early Levantine Mousterian (corresponding to Unit IX at Tabun) generally show low densities of artifacts and other features characteristic of high residential mobility. Assemblages from the later Middle Paleolithic, on the other hand, display a much wider variation in how the sites were used. Similarly, at Tabun, the unit representing the early Levantine Mousterian (Unit IX) is clustered in the upper left of the continuum where density is low and tool-to-flake ratio is high. The other units are distributed more evenly along the continuum with some falling among the Unit IX beds and others exhibiting high density but low tool-to-flake ratios.

The relationship between and among the lower units is particularly thought provoking. Taken singly, correlations for a few units approach but do not meet statistical significance, though they are not particularly strong (in particular, Unit XIV). The different facies of the Acheulo-Yabrudian do not display any differences in pattern and instead conform to the overall signal of consistently high artifact density and tool frequency. In contrast to the Mousterian layers, density and retouch ratios appear essentially unrelated. Unit X, the transitional (or mixed) layers between the Acheulo-Yabrudian and Mousterian, falls neatly between the two trends, with the earlier beds falling among the Acheulo-Yabrudian distribution and the later deposits aligning with the Levantine Mousterian correlation.

DISCUSSION

This analysis reveals a significant difference between the Lower and Middle Paleolithic periods at Tabun in the relationship between indicators of occupational intensity and strategies of artifact production. An important question at this point is whether this apparent change is due to fundamental differences in organization of mobility and site use, or whether it is simply connected with a change in the rate of sediment accumulation. However, as was reviewed earlier, the cave was filled by eolian sediments for the majority of its occupation and thus the rates of sediment accumulation would have been relatively constant, or would at least have varied over similar ranges. The major change in sedimentary regimes occurred at the top of the sequence when the chimney opened and a large amount of sediment was washed in (fig. 3). Much of this part of the sequence was excavated by Garrod, but more importantly, it occurs late in the sequence and not within Unit X, where we see the major pattern change in this analysis. The Acheulo-Yabrudian beds, where the greatest variation in artifact density is evident, consist entirely of aeolian sands. There is evidence for erosion and sediment removal through the "swallow holes" but from profile drawings I identified the beds that appeared to have been most affected by this process and removed from the analysis.

Another explanation for the pattern change could be simply an evolution in the cave's topography. As the Tabun Cave filled with sediment and the overhang moved back (through small-scale collapses), the part of the occupied space sampled by

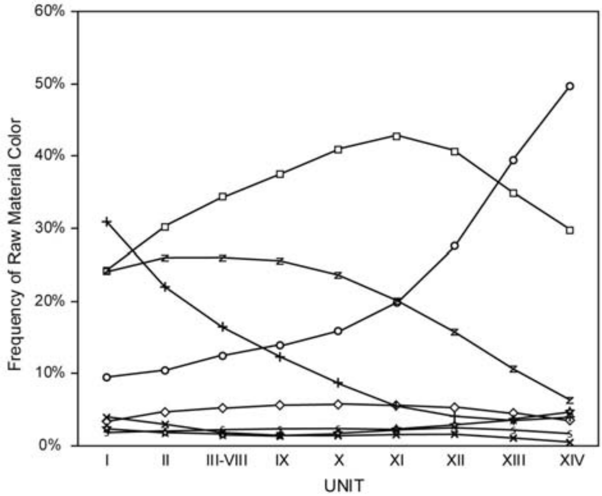
Jelinek's trench would have shifted. As a consequence, the use of the excavated area might have changed even while the use of the cave as a whole remained the same. For example, if the back of the cave was infilling, it would have become a more cramped place and less ideal for a habitation surface. This could have led to its transition into a trash midden instead of an activity area which would have indeed changed the pattern that is evident in this analysis. However, if this were the case, one would expect the change to occur gradually over the sequence, as the area became less conducive for certain activities. Instead, the pattern of change revealed in my analysis occurs comparatively abruptly within Unit X, and therefore is unlikely to be the result of a bias in the location of excavation.

It is possible, even likely, that the effects of climatic change on local resources led to changes in how the site was utilized. Paleoclimatic data indicate that the Levant was wet and cool during glacial periods and warm and dry during interglacial periods (Frumkin et al. 2011) but overall temperature and vegetation changes would have been much less dramatic than in other regions. In addition, during glacial conditions the coastal shelf would have been exposed, leaving the seacoast an additional 20 km away from the site. However, because the sequence at Tabun spans oxygen isotope stages 6 through 9, neither climatic change nor access to sea resources are likely to explain the categorical differences between the upper and lower sections of the cultural stratigraphic sequence. The climate was fluctuating throughout the occupation, but equally throughout both the Middle and Lower Paleolithic and not merely at the transition between them. It is likely that some changes in site use within the Lower and Middle Paleolithic could be explained with reference to climate change. This is particularly the case for the Middle Paleolithic where we see rather low density, short occupations (high residential mobility) in the early Middle Paleolithic during a glacial period (OIS stage 8) and higher density (more intense occupations) in the later Middle Paleolithic when the region was warmer. However, the earlier beds saw similar climate fluctuations and no such effects are apparent.

Differential availability of raw materials would certainly influence strategies of raw material use and the amount of debris generated during tool manufacture, yet there is no evidence that access to high quality chert varied substantially over the occupational history of Tabun. There are a number of sources of good quality raw material located within a few kilometers of Tabun, and the same raw materials appear to have been utilized during the entirety of habitation, with only shifts in the relative abundance of each raw material category (fig. 7). This, therefore, does not seem to have had any great affect on the changes in the way these tools were manufactured and utilized.

Could the specific technological procedures employed and differing characterizations of "tools" verses "flakes" between the two periods have altered the way this pattern was displayed? This is unlikely. The negative correlation between artifact density and retouch frequency has been observed consistently throughout Europe, in a diversity of industries, many of them with discoidal reduction and an emphasis on scrapers, like the Acheulo-Yabrudian. Kuhn's work at Riparo Mochi in Italy, for example, showed negative correlations between artifact density and tool frequency within an industry produced by discoidal reduction and a dominance of notches, denticulates, and scrapers (Kuhn 2004), as well as in assemblages with more unidirectional production. A variety of sites in the Carpathian Basin also followed the expected pattern

Fig. 7. Tabun Cave. Frequencies of the eight raw material color categories plotted by unit. All categories are high quality chert and although their relative frequencies varied over time, the same materials were used throughout the sequence.



where the majority of Mousterian assemblages are non-Levallois and dominated by scrapers (Riel-Salvatore et al. 2008). It also holds in the Upper Paleolithic. It appears, therefore, that this pattern persists across a diversity of assemblage types and technologies and it is not clear why the Acheulo-Yabrudian should be any different simply based on the way artifacts were produced.

The overall values for the tool-to-flake ratio and artifact density are consistently high for the pre-Mousterian beds (Table 3). The density values seem to indicate that there was a particularly intensive use of the site during this period of time in comparison to most of the Middle Paleolithic. However, if we interpret the "intensive" use of the site to mean occupation of longer duration, we would assume tool-to-flake ratios to be lower as a result of the debitage produced through *in situ* core reduction. Perhaps, instead, the inhabitants were using the site as the ultimate provisioned locale and simply reusing the discarded flakes and tools again and again, rather than provisioning the site with new resources (Kuhn 1992). Yet this does not appear to have been linked to a scarcity of local raw materials, since the same raw materials were available throughout the sequence. In any event, it would still stand in strong contrast to the later Mousterian, where we have evidence for a range of strategies.

Table 3. Tabun Cave. Means and standard deviations for the tool-to-flake ratios and artifact densities within the Lower and Middle Paleolithic units. Density is expressed in lithics/m^3.

	Mean	σ
T/F Ratio, MP layers:	0.111624	0.0874
T/F Ratio, LP layers:	0.631051	0.326
Density, MP layers:	833.808	0.166
Density, LP layers:	1575.27	0.119

Another, more interesting explanation for the anomalous associations between artifact density and retouch frequency in Units XI-XIV at Tabun could relate to the way that the inhabitants structured their mobility and regional land use. While the Middle Paleolithic people were utilizing a strategy that follows the expected trend evident at other sites, earlier groups may have been doing something different. One hypothesis is that the pre-Mousterian inhabitants of the cave were highly mobile and visited the site for only brief periods, yet returned very frequently. High artifact densities would reflect strictly the frequency of visits, and not their duration. The abundance of retouched tools, some very extensively reduced, would reflect overall high levels of residential mobility and little artifact production in and around the cave.

Variation in frequency of visits might in turn be related to location of the site within shifting territories and thus randomized. When the cave was near the center of a group's territory hominins might return there quite often. At other times, Tabun could have been located at the edges of a population's territory or "home range," meaning that it was visited infrequently, producing much less dense deposits of artifacts. Regardless, it appears that the pre-Mousterian peoples utilizing the site either never chose to stay for longer periods, or, if they did, never adjusted their strategies of artifact production and renewal.

The reasons for a major reorganization of land use between the Acheulo-Yabrudian and the Levantine Mousterian are difficult to identify from the data at hand. Perhaps it was simply a different way of provisioning themselves and exploiting the local environment. Mousterian people may have been using the site during some periods as a "base camp" while during other periods as a quick camp site for a very mobile group. The evidence from the Mousterian levels does not show quick transitions, however, from a short-term mobile site to a provisioned long-term site, but, rather, long periods of use as a mobile camp site and other periods used repeatedly as a "base camp."

In order to test these propositions, I made a comparison between the percentages of burned lithics in the assemblage and their relationship with density. I assume that lithics are burned accidentally, through being tossed into fires or having fires built on top of them. If density reflects length or overall intensity of occupation, one would expect the denser layers to have higher percentages of burning than those beds that have lower density. This is expected for two reasons: 1) because there are more lithics in these layers in general, more things should be burned when a fire is lit and 2) higher density signifies higher intensity of occupation, meaning both a higher number of fires and also fires that continue to burn for longer periods and are hotter and more intense. As might be expected, the Levantine Mousterian follows this trend for the most part. While the relationship is not strong, it is significant ($r=.3351$, $p < .05$, $df = 58$) and the majority of beds that lowered the significance were those levels that were of low density but with higher percentages of burned flakes (fig. 8). This might be due to materials being burned by fires from overlying levels.

The Lower Paleolithic units, however, did not follow the expected trend. Here, the percentage of burned flakes is negatively related to density (fig. 9). This negative correlation is significant with an r value of -.3947 ($df = 93$, $p < .001$). Therefore, during periods of lower density when the site was visited less often, there is a higher degree of burning among the lithics. This trend could be linked to a number of different scenarios. During periods of frequent use, for example, hominids may have been using the site briefly but not staying long enough to kindle fires. In beds exhibiting lower density, when perhaps the site was located further from the center of the territory, hominids may have chosen to stay for long periods of time, overnight or for a few days. While this scenario fits in well with the hypothesis of how Tabun was used during the pre-Mousterian occupation, this pattern could also be produced by changes in the location of either fires or tool production. Looking closely at the distribution of units within the relationship, Unit XI tends to exhibit higher percentages of burning. This could indicate an increased use of fire corresponding to the onset of glacial conditions (from OIS 9 to 8).

Fig. 8. Tabun Cave. Percentage of burned lithics plotted against artifact density for the Levantine Mousterian beds (Units I-IX). The positive correlation is significant (r = .3351, p < .05, df = 58). Density is expressed in lithics/m³.

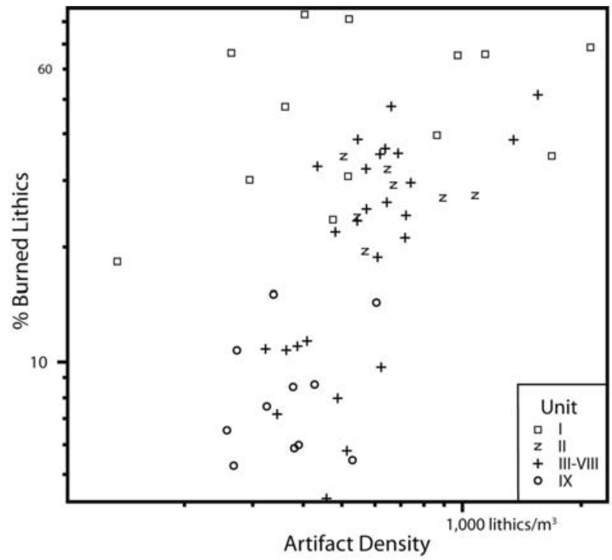
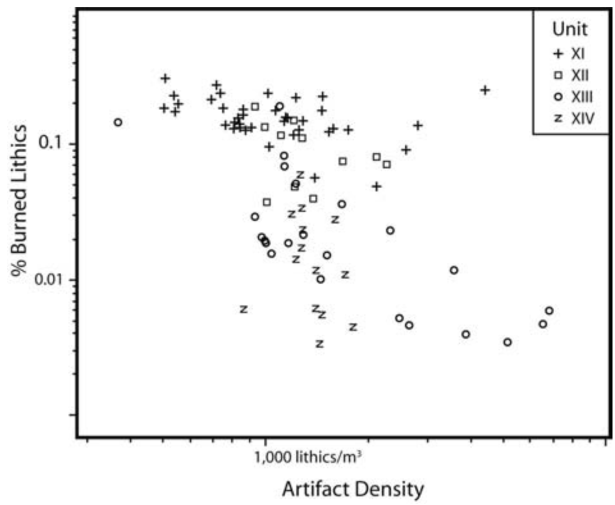


Fig. 9. Tabun Cave. Percentage of burned lithics plotted against artifact density for the Acheulo-Yabrudian beds (Units XI-XIV). The negative correlation is significant (r = -.3947, df = 93 p < .001). Density is expressed in lithics/m³.



In general, the level of burning evident in the Acheulo-Yabrudian beds is low compared to the Mousterian layers, showing that fewer fires were lit and did not burn long enough to alter many of the lithics. This evidence again supports a significant change in the way Tabun was used from the Lower to Middle Paleolithic. Generally, it appears that hominids utilizing the site in the Lower Paleolithic did not stay at the site long enough to build substantial fires. Moreover, the lack of fire damage in the high density beds supports the conclusion that these were not provisioned locations intended for extended habitation as is the case for the high density beds in the Middle Paleolithic. This is in contrast to evidence from the nearby Acheulo-Yabrudian site of Qesem Cave where extensive hearths and hearth-related activities have been documented (Stiner et al. 2011).

CONCLUSION

The analysis reported here reveals fundamental differences in the way the Acheulo-Yabrudian inhabitants of Tabun Cave used the site in contrast to people who produced the Levantine Mousterian industry there. This difference appears to be due mainly to changes in frequency and duration of habitation. During the Acheulo-Yabrudian period, I hypothesize that residents of Tabun were highly mobile yet occupied a small territory, resulting in frequent visits of short duration. This is supported by the low frequency of burned lithics throughout most of the beds, indicating that few fires were lit and those that were only burned for short periods. Tabun might at times have been situated near the center of a small territory, leading to the production of dense beds with many moderately retouched artifacts. During other periods, it might have been located closer to the periphery of the territory, resulting in a more dispersed accumulation of highly reduced artifacts.

At the onset of the Levantine Mousterian, the mobility pattern changed into one that characterizes other sites in Europe (Kuhn 2004; Riel-Salvatore and Barton 2005; Riel-Salvatore et al. 2008). The site of Tabun alternated between a briefly-visited campsite and a habitation site of longer duration. During some periods, these signals are clear and the patterns fall on one end of the spectrum, but during other periods, hominids may have changed their behavior more often, leading to a mixed signal. When the site was inhabited for longer periods, the site was provisioned with local raw materials, and a greater amount of flake production took place at the site. The tools, therefore, were more expediently used and generally not retouched, and finished items carried to the cave would have been overwhelmed by the tools and debris produced in place. During other periods, Tabun Cave was not a center of many different activities, but, rather, was used as a short-term camp. In this context, well-used tools carried as part of individual tool kits make up a larger part of the record, increasing the tool-to-flake ratio. One cannot exclude the possibility that the changes in site use were the result of different activity sets rather than mobility patterns; however, the explanation provided here is consistent with other indicators such as the frequency of burned artifacts. Moreover, the findings at Tabun are consistent with results of other analyses of mobility in the Levantine Mousterian.

Particularly within deep time, it is nearly impossible for archaeologists to tease out the structure of the settlement system for a particular region and period of time, much less based on only one site. Even if one were able to identify all locations utilized, whether ephemerally or for a sustained period, one would still be left to tackle the palimpsest of changing settlement systems over hundreds or even thousands of years. Moreover, it is very seldom possible to know from dates or geological information alone whether two sites were actually in use at the same time. Barring fortunate cases of inter-site refits, this may be unknowable. In the case of a site like Tabun, what we can do is attempt to identify the duration of occupation and the frequency and, from this, extrapolate a general notion of how people were moving about the landscape, how frequently it was changing, and if there were any long-term directional change. Putting together the parts of the system is as much a theoretical exercise as it is a matter of identifying all possible components of a regional settlement system.

At Tabun Cave, Acheulo-Yabrudian people seemingly did not vary their mobility pattern very much, only perhaps the location of their territory. Middle Paleolithic people, on the other hand, appear to have had a more dynamic mobility pattern, one which changed often, perhaps integrating many kinds of sites, and which utilized Tabun differently during the earlier and later parts of the Levantine Mousterian. In this way, we can obtain a general picture of what mobility patterns may have been like in the Levant, and comparing Tabun Cave with other Levantine sites will only help to clarify these general ideas. There is no need to force the general tendencies that we can resolve from this analysis into discrete categories such as "foragers" and "collectors." To do this would serve no purpose other than to create a feeling of satisfaction in the attribution of a label and might instead stifle further understanding of the diverse land use strategies of early humans and *Homo sapiens* alike.

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