The North Syrian Late Epipalaeolithic

The earliest occupation at Tell Abu Hureyra in the context of the Levantine Late Epipalaeolithic

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PREFACE

In 1980, I was offered a unique opportunity to work with chipped stone collections from a site, Tell Abu Hureyra, dating to the late Epipaleolithic from the Near East. This time period intrigued me since it was regarded as the "transitional" period from a hunting and gathering way of life to one of agriculture, domesticated animals and settled villages.

From the outset, I was particularly interested in investigating the question of the extent to which activities, reflected by the relative abundance of tool types at sites, were similar or dissimilar from site to site throughout the Levant and, in particular, how such activities may have differed at Tell Abu Hureyra. The chipped stone assemblage from Tell Abu Hureyra represented an opportunity to look in detail at a late Epipaleolithic assemblage from northern Syria, as opposed to one from Palestine. This was an important point because excavated sites with some depth of deposits dating to this time period were virtually unreported in detail for areas outside of the Palestinian region.

As I became increasingly familiar with the literature for this time period and area of the world, I was struck by the fact that most researchers referred to assemblages from this time period as "Natufian," thereby implying that the "Natufian" complex was a pan-Levantine phenomenon. This seemed somewhat unusual, since in both the preceding early Epipaleolithic and succeeding early aceramic Neolithic periods, a considerable array of diversity among assemblages had been acknowledged and this diversity had been used to establish separate regional industries. The sudden disappearance of this regional industrial diversity for only the the duration of the late Epipaleolithic period seemed to be an odd occurrence. Thus, since I was examining a chipped stone collection from a non-Palestinian area, I decided to utilize a method of typological classification that was as consistent as possible with the classifications that had been previously employed for the Natufian collections. This enabled me to compare the Tell Abu Hureyra assemblages with the known Natufian assemblages and with other northern Syrian assemblages and to assess whether or not a case could be made for the existence of diverse regional industries during the late Epipaleolithic.

Thus, I had four major aims and goals in mind. These were to provide a complete and detailed description of the Tell Abu Hureyra chipped stone assemblage, from Trench E Levels 280-330, to examine the patterns of variability that could be distinguished among Levantine chipped stone assemblages dating to the late Epipaleolithic, to explore possible explanations for the patterns present in the chipped stone assemblages, and to examine the possibility that the Levantine late Epipaleolithic was more complex in terms of regional diversity than had been suggested by the previous work done on this time period. I also hoped to be able to relate the information derived from the analysis of the chipped stone assemblages to that known concerning the use of plant and animal resources, the architectural features, and the general topographic and environmental setting at Tell Abu Hureyra in comparison to the Palestinian sites. These other sources of information provided a more complete picture of the late Epipaleolithic development than could be achieved solely through the use of chipped stone.

During the course of my dissertation research, many people have inevitably been associated with the various aspects of my thesis. I would like to thank the members of my committee; my chairperson, Arthur J. Jelinek, the other members of my committee, Andrew M. T. Moore, Paul R. Fish, and Raymond H. Thompson, for their support and help over the years, and for the thoughtful criticisms they provided on earlier versions of my dissertation. I would also like to extend an added note of thanks to Andrew Moore, who offered me the opportunity to work with the materials from the late Epipaleolithic occupation at Tell Abu Hureyra, and to Arthur Jelinek who suggested many analytical insights and methods.

A portion of my research involved examining late Epipaleolithic collections now housed at various institutions throughout Europe and the United States. I received a warm welcome and kind assistance everywhere I went. In this connection, I would like to thank the following individuals. In England, the assistance of Derek Roe of the Donald Baden-Powell Quaternary Research Centre, Oxford; Ray Inskeep of the Pitt-Rivers Museum, Oxford; P. R. S. Moorey of the Ashmolean Museum, Oxford, G. de G. Sieveking and Penny Robinson of the British Museum, London; P. L. Carter of the University Museum of Archaeology and Anthropology, Cambridge; and Mark Newcomer of the Institute of Archaeology, London, was invaluable. In France, J. and M.-C. Cauvin permitted me the opportunity of seeing a small portion of the Tell Mureybat collections in Lyon. In the United States, A. E. Marks and D. Kaufman kindly allowed me to examine the Negev collections at Southern Methodist University, Dallas. The time and attention all of these people extended to me is greatly appreciated.

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I also owe a great debt to all my friends who listened to my endless ramblings on the subject of the Levantine late Epipaleolithic. In particular, I wish to thank Patty Anderson-Gerfaud, Mike Barton, Mark Baumler, Chris Bedegrew, Chris Bergman, Mary Bernard-Shaw, Phil Chase, Harold Dibble, Sandi Kobzina, Margaret MacMinn, Chet Shaw, and Alan Simmons. Their friendship over the years has meant much to me.

Finally, I wish to thank my mother, who provided emotional and financial support, both of which were greatly needed at times.

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ABSTRACT

The study of the interrelationships between Levantine late Epipaleolithic chipped stone assembleges is essential for an understanding of the cultural developments responsible for early plant and animal domestication. The analysis of the differences and similarities in technological and typological attributes of chipped stone assemblages, in conjunction with site locale, material remains other than chipped stone, and reconstructions of prehistoric enviornmental and climatic conditions, leads to an increased awareness of the kinds of activities preacticed by prehistoric groups in different areas of the Levant at that time.

Until recently, a majority of the research on the Levantine late Epipaleolithic was confined to the Palestinian area, and to the Natufian complex that characterizes that region of the Levant. The analysis presented here are concerned with the description and interpretation of a late Epipaleolithic chipped stone assemblage from the northern Levant at Tell Abu Hureyra on the Euphrates River, and the ways in which this assemblage compares and contrasts with those from the Natufian area. This research provides new and important information about prehistoric activities in an area outside of the traditional Natufian core region of Palestine.

A complete typological description of the Tell Abu Hureyra chipped stone assemblage from Trench E Levels 280 to 330 is presented. This information is used to compare these materials with the assemblages from other north Syrian sites (Tell Mureybat, Dibsi Faraj East, Nahr el-Hown, and Aarida 7).

Using general tool classes, such as scrapers, burins, and notch/denticulates, the north Syrian assemblages are then compared, by means of distance coefficients, cluster analysis, and principal components analysis, with Natufian assemblages. The lunate, a geometric microlith, is examined in particular. The chronological value of lunate attributes established by certain authors is examined for lunates from Natufian assemblages and from the Tell Abu Hureyra assemblage. The information derived from these analyses is assessed in conjunction with envioronmental data, and specific site locale (such as open-air shelter) to construct a general interpretation of the significance of the variability in the late Epipaleolithic chipped stone assemblages of the Levant.

CHAPTER 1

INTRODUCTION

The Levantine late Epipaleolithic was a time period during which the hunting, gathering, and collecting way of life began to emphasize those aspects which culminated in sedentary settlements, agriculture, and animal domestication. Although morphologically domesticated plants and animals in any abundance were not to appear until at least a millennium after the end of the late Epipaleolithic, in order to understand these developments, the late Epipaleolithic is a necessary focal point.

Definitions

In the following discussions, the terms "Levant" and "Levantine" refer to areas encompassed by Syria, Lebanon, Jordon, Palestine, and to the Negev Desert and the northern Sinai Desert. The practice of labeling all Levantine sites dating to the late Epipaleolithic as "Natufian" will not be followed. Instead, it will be shown that the term Natufian should be reserved for the Palestinian and southern desert and steppe areas.

Chronology

On the basis of present evidence, the late Epipaleolithic in the Levant dates from about 10,500 b.c. to about 8,300 b.c. This range is based on uncalibrated radiocarbon dates (here designated as b.c.), calculated on the Libby half-life, from sites representing the end of the final phase of the early Epipaleolithic (Geometric Kebaran A) and from sites with assemblages characteristic of the early and late phases of the late Epipaleolithic. Thus, a date from the Geometric Kebaran A (Falitian) at Ksar 'Akil (Thommeret and Thommeret 1973:337) places this occupation at about 12,150 ± 500 b.c. (Mc-411), and a similar occupation at site D5 in the Negev Desert at 11,220 ± 230 b.c. (I-5497) (Buckley 1973:295).

Early dates from the late Epipaleolithic are represented by the recent finds at the Wadi Judayid in southern Jordan. These are 10,140 ± 800 b.c. (SMU-805), 10,800 ± 1,000 b.c. (SMU-806) and 10,834 ± 659 b.c. (SMU-803) (Henry 1982:437). The great majority of C-14 dates for late Epipaleolithic occupations fall within the 10th millennium, at sites such as Hayonim Terrace Layer D, Mugharet el-Wad Layer B2, Ain Mallaha, Tell Abu Hureyra, Mugharet el-Kebarah Layer B, and Jericho.

Radiocarbon dates relating to the end of the late Epipaleolithic are known from three sites, Rosh Horesha, Tell Mureybat, and Tell Abu Hureyra. The Rosh Horesha occupation produced dates of 8,930 ± 280 b.c. (SMU-10) and 8,540 ± 430 b.c. (SMU-9) (Haynes and Haas 1974:379). The

Tell Mureybat Ia dates are 8,400 ± 150 b.c. (Mc-675), 8,220 ± 200 b.c. (Mc-635), 8,280 ± 170 b.c. (Mc-731), and 8,150 ± 170 b.c. (Mc-732) (M.-C. Cauvin 1980:17). At Tell Abu Hureyra, recently obtained radiocarbon dates from Trench E Level 275 place the upper portion of the occupation late in the Epipaleolithic sequence, 8,100 ± b.c. (OxA-407) and 8,300 ± 160 b.c. (OxA-408) (Moore 1985: personal communication).

It is clear that in some Levantine regions, the late Epipaleolithic time range should be extended a century or so earlier or later than the range proposed, since the beginning and the end of the late Epipaleolithic was not a simultaneous occurrance throughout the Levant. However, it is convenient to accept the 10,500 to 8,300 b.c. range, since most late Epipaleolithic occupations in the Levant are dated to within this period.

Problems and Goals

The vast majority of the research concerning the late Epipaleolithic in the Levant has been concentrated in the south, in the Natufian area. This has led to an emphasis on the interpretation of Natufian assemblages for the understanding of cultural development in this region at the end of the Pleistocene. Changes occurring in the methods used to exploit food resources during the late Epipaleolithic eventually led to the establishment of developed agriculture (morphologically domesticated cereals and livestock). The beginnings of this agricultureal life-style can be seen in the early aceramic Neolithic period (Proto-Neolithic and Pre-Pottery Neolithic A), which succeeds the late Epipaleolithic, and dates from within approximately a few centuries of 8,000 and lasts until about 7300 b.c. (Bar-Yosef 1980:127).

Interesting and important new information from the northern Levant, that allows one to look beyond the Natufian as the only source of these developments, is now available. Recently, excavations at the sites of Tell Abu Hureyra and Tell Mureybat in northern Syria have resulted in the acquisition of data pertinent to late Epipaleolithic occupations in a non-Natufian area. It is the earliest occupation (Trench E Levels 280 to 330) at Tell Abu Hureyra, dating to the late Epipaleolithic, that is the focus of the following work. The primary emphasis is on a detailed discussion of the chipped stone assemblage from this time horizon at Tell Abu Hureyra, and the ways in which this assemblage compares and contrasts with other late Epipaleolithic assemblages in the Levant.

Chipped stone artifacts, because they are abundant at many late Epipaleolithic sites, and because they are the only artifacts at most sites, are an important source of information on prehistoric activities and stylistic affiliations of industries. Thus, an examination of the relationships between tool classes at Levantine sites might be expected to delineate associations, for example, between environmental zones and tool assemblages, or between tool assemblages and activity loci within site areas. The analysis and interpretation of these relationships is one aim of the following work.

The manufacture of new tool types can be established through the comparison of chipped stone assemblages chronologically and spatially. This is another aim of the discussions relating to the Tell Abu Hureyra artifacts.

A final major goal of the following work is to provide a complete and detailed description of the chipped stone artifacts from Tell Abu Hureyra, Levels 280-330, Trench E. This is an important contribution since the late Epipaleolithic materials from this site have not been previously described in detail. The analysis of these materials is integral for the broader understanding of late Epipaleolithic developments occurring outside the Natufian area.

A brief review of early Epipaleolithic developments leading to the late Epipaleolithic, and of the subsequent early aceramic Neolithic, is presented as a background against which the interpretative problems of the late Epipaleolithic can be understood. This is followed by a detailed discussion of the Near Eastern late Epipaleolithic which is included to provide perspective for the following discussions of the Tell Abu Hureyra industry and of the evidence other than chipped stone obtained at Tell Abu Hureyra.

The next chapter examines the chipped stone from Tell Abu Hureyra. A complete descriptive analysis is provided. These data, in conjunction with published accounts of assemblages from other Levantine late Epipaleolithic sites, are then used in several comparative analyses, including distance coefficients, and cluster and principal components analyses. A final typological comparison of the Tell Abu Hureyra materials with assemblages from the Natufian area is used to determine the extent of the relationship between these Levantine late Epipaleolithic industries.

In addition to a detailed examination of the Tell Abu Hureyra industry, the lunate, a hallmark tool of the late Epipaleolithic, is also discussed. Previous research on lunate attributes, such as length and type of backing retouch, has indicated that these attributes have chronological value (Bar-Yosef and Valla 1979; Valla 1981). The aim in this study is to determine whether or not lunates from the northern Levant follow the same pattern as those from the Natufian area and to assess the general validity of the chronological value of lunate attributes.

Finally, an overall summary and conclusions are presented.

CHAPTER 2

A BRIEF OVERVIEW OF THE ARCHAEOLOGICAL EVIDENCE FOR THE EPIPALEOLITHIC AND EARLY ACERAMIC NEOLITHIC IN THE LEVANT

This synopsis of the industries of the Levant from the Epipaleolithic through the early aceramic Neolithic is presented to provide a framework within which the development of the Natufian and other late Epipaleolithic complexes of this region can be understood. This brief introduction begins with a review of the major characteristics of the succession of periods leading up to the appearance of the late Epipaleolithic, followed by a short account of the late Epipaleolithic, and concludes with a discussion of the period immediately postdating the late Epipaleolithic. A more detailed discussion of the Natufian and other late Epipaleolithic industries will be presented in Chapter 3.

The Levant consists of several topographically distinct areas. These include the northern Sinai and the Negev Deserts, the coastal area bordering on the Mediterranean Sea, the Lebanon and Anti-Lebanon Mountains, the Jordan Rift Valley, the western portion of the Transjordanian Plateau, and parts of the Syrian steppe and desert (Fig. 1). These regions are characterized by diverse environmental regimes (Table 1). Prehistorically, the desert regions were significantly altered during periods of lower temperature or higher rainfall. This encouraged human exploitation of resources in territories which today would be considered marginal, at best, for hunter-gatherer groups.

The Epipaleolithic of the Levant covers a time period of approximately 8,700 radiocarbon years, from 17,000 to 8,300 b.c. The early aceramic Neolithic lasted from about 8,000 to 7,300 b.c. (Bar-Yosef 1980:119-127; M.-C. Cauvin 1981b:439-440; Sanlaville 1981:158-159, 160-161). These several thousands of years represent the evolution of several chronologically and spatially recognized industries in a variety of geographical habitats, through several climatic oscillations and their attendant enviormental changes.

Kebaran

One of the first industries to appear in the Levant following the Upper Paleolithic was the Kebaran. The Kebaran, which dates to the period between 17,000 and 12,500 b.c. (Bar-Yosef 1980:119), was recognized as a distinct archaeolgical entity during the excavations by Turville-Petre in 1931 at the site of Mugharet el-Kebarah in Palestine (Turville-Petre 1932:271). Beyond the identification of the Kebaran, the Kebarah excavation demonstrated the chronological order of the two Epipaleolithic complexes known at that time, the Natufian

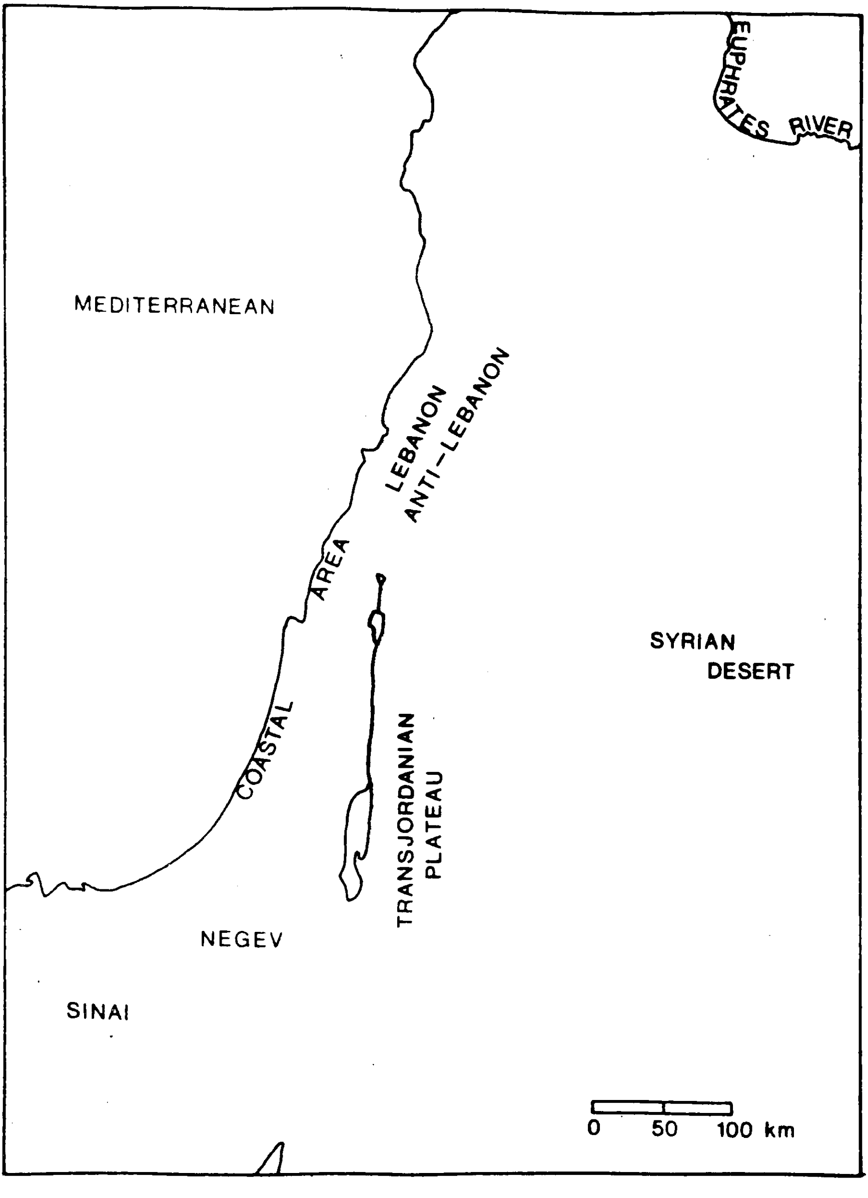


Figure 1. Environmental regions of the Levant.

Table 1. Description of the environment of regions of the Levant. -- Regions of the Levant (after Aurenche et al. 1981:580-581).

Region	Environment
Sinai and Negev Deserts	subdesertic (Syrian Desert type) and/or steppic, borders the margin of the Fertile Crescent
coastal area (Mediterranean)	includes part of the Fertile Crescent, Mediterranean climate (humid)
Lebanon Mountains	humid and wooded (Mediterranean forest)
Anti-Lebanon Mountains	steppic, open forest vegetation
Jordan Rift Valley	steppic, warm and dry
Transjordanian Plateau	borders the Fertile Crescent, subdesertic (Syrian Desert type)
Syrian steppe and Desert	subdesertic (borders the Fertile Crescent in the northern Syrian Euphrates area)

and the Kebaran. The stratigraphic sequence at Kebarah showed that the Kebaran level was lower than the Natufian level, and therefore, earlier.

The Kebaran complex is characterized by the production of narrow bladelets, many of which are modified into nongeometic microliths, for example, truncated, backed bladelets, and curved, backed bladelets (Bar-Yosef 1970a:169, 1975:368, 1981:392). Bar-Yosef (1970b:62) has defined Kebaran industries as those with 20% or more microliths, less than 2% geometric microliths, and 10-20% burins. Spikey points, curved backed bladelets, narrow micropoints, and obliquely truncated bladelets are the main microlithic types. Other elements of the chipped stone assemblage include scrapers, notches, truncated pieces, and denticulates. Bone tools tend to be scarce, while grinding and pounding implements, in small numbers, are known from several sites, including En Gev I (Stekelis and Bar-Yosef 1965:182), Hefzibah (Ronen et al. 1975:57), and Nahal Hadera V (Saxon, Martin and Bar-Yosef 1978:254). Site size ranges from 25 m2 to 400 m2 (Bar-Yosef 1981:392-396). Hut structures have been located at En Gev I (Arensburg and Bar-Yosef 1973:201) and Jiita II (M.-C. Cauvin 1981b:439).

Recent research on the Kebaran complex has suggested the presence of several internal divisions. These have been separated spatially and chronologically. Thus, for example, Bar Yosef (1975:368; 1981:392-396) has recognized the presence of four groups (A to D) in the southern Levant that are defined by differing frequencies of particular types of microlithic backed bladelets (Table 2). Two of these, clusters C and D, are probably ordered chronologically. Clusters A and B may be earlier than C and D. In addition, cluster A is probably a regional manifestation.

In the central Levant, several chronological phases of the Kebaran have been distinguished on the basis of variations in microlithic types. These phases include the proto-Kebaran at Ksar 'Akil (M.-C. Cauvin 1981a:339), the early Kebaran at Jiita II (Hours 1973:198-199; Hours and Loiselet 1975-1977:169-174), and the classic Kebaran at Jiita II (Hours 1973:198-199; Hours and Loiselet 1975-1977:169-174) and Abri Bergy (Copeland and Waechter 1968:33). At the present time, it is not possible to completely correlate the Kebaran phases from the central Levant with those from the southern Levant because of the lack of sufficient C-14 dates and differing classification methods. However, both Bar-Yosef and Hours and Loiselet are in agreement concerning the chronological importance of differences in microlithic types at Kebaran sites.

Another region that demonstrates the existence of spatial variation within the Kebaran time period is southern Jordan. Here, Henry (1982:430) has proposed two new industrial taxa, the Qalkan and the Early Hamran. The Qalkan differs from the Kebaran in its use of the microburin technique, the production of wide blades and bladelets, and the presence

Table 2. Kebaran microlithic tool cluster proposed by Bar-Yosef.

Kebaran Tool Clusters (after Bar-Yosef 1981:392-396)	Tools
Cluster A	
early phase	
Kiryath Arieh II Kefar Darom 3	narrow micropoints with finely retouched bladelets
later phase	
Kefar Darom 8 Soreq 33Q Soreq 33T	broad micropoints
Cluster B	
Poleg 18MII Fazael III 6 Azariq VI	curved and pointed backed retouched bladelets
Cluster C	
Hayonim Cave C Meged rockshelter Nahal Oren IX Kebarah C Nahal Hadera V 6-4 Give'ath Ha'esev Soreq 33M2 Kefar Darom 13	narrow micropoints and obliquely truncated backed bladelets
Cluster D	
En Gev I-II Umm Khalid Hadera V 1-2 Hefsibah lower levels Fazael III 4 Fazael VII Haifa I Soreq 33M1	obliquely truncated backed bladelets with narrow curved bladelets shaped by semi-abrupt to abrupt retouch

of the Qalkan point. The Early Hamran also differs from the Kebaran in the production of wide blades and bladelets.

The distribution of Kebaran period sites (Fig. 2) in part reflects prevailing environmental conditions. Thus, while the earlier presence of Upper Paleolithic sites such as Sde Divshon A and Ein Aqev East in the Negev Desert (Ferring 1976, 1977), and the Lagaman industry of the northern Sinai (Bar-Yosef and Phillips 1977:256-257) suggests that these desertic regions then enjoyed a more favorable climate than that of the present day, the absence of the later Kebaran sites from these areas indicates that, by that time, environmental conditions were not conducive to either settlement or transitory camps.

On the basis of pollen cores from various areas in the Near East (Ghab and Zeribar), some researchers have suggested a relatively cool and arid climate for the time period corresponding to the Kebaran occupation (Bottema and van Zeist 1981:116-118). The initial information derived from a pollen core at Lake Hula (K-Jam) suggested that, contrary to the Ghab and Zeribar areas, northern Israel was moist (Horowitz 1971:267). However, a recent examination of another Lake Hula core by Tsukada (Bottema and van Zeist 1981:115) shows the lowest arboreal pollen percentage during the pollen zone corresponding to the Kebaran period. This evidence complements the Ghab and Zeribar cores.

The cool and dry environment existing over such of the Near East during the Kebaran period appears to have affected settlement in only the modern desertic regions. Kebaran sites are found in all of the other environmental zones. Thus, for example, Hefzibah (Ronen et al. 1975) and Nahal Hadera V (Saxon et al. 1978) are on the coastal plain, el Khiam (Gonzalez-Echegary 1964, 1966) in the Judean Hills, Jiita II (Hours 1973), Dhour Choueir (Hours 1976), and the Abri Bergy (Copeland and Waechter 1968) on the mountain slopes, Yabrud III (Rust 1950) in the mountains, and Wadi Madamagh (Kirkbride 1958) and Nahr el-Homr (Boerma and Roodenberg 1977: Roodenberg 1976) in the steppe. The Qalkan and Early Hamran sites found in southern Jordan are located in a situation modified by the conjunction of three phytogeographic zones, Irano-Turanian, Sindo-Saharan, and Mediterranean (Henry 1982:418).

The existence of Kebaran sites in such a wide variety of environmental habitats indicates the usage of an extensive array of plant and animal resources. One of the most important exploited faunal resources in Palestine was the gazelle. It was found at sites such as Nahal Oren IX (Noy, Legge and Higgs 1973:90), Mugharet el-Kebarah Layer C (Saxon 1974:33), Fazael III (Bar-Yosef, Goldberg and Leveson 1974:420), and En Gev I (Davis 1974:453). Farther north, on the slopes of the Lebanon Mountains, at Ksar 'Akil, fallow deer and goats were intensively utilized (Hooijer 1961:Table 25). The steppic and hilly environment at the Wadi Madamagh allowed the exploitation of goats (Perkins 1966:67). A

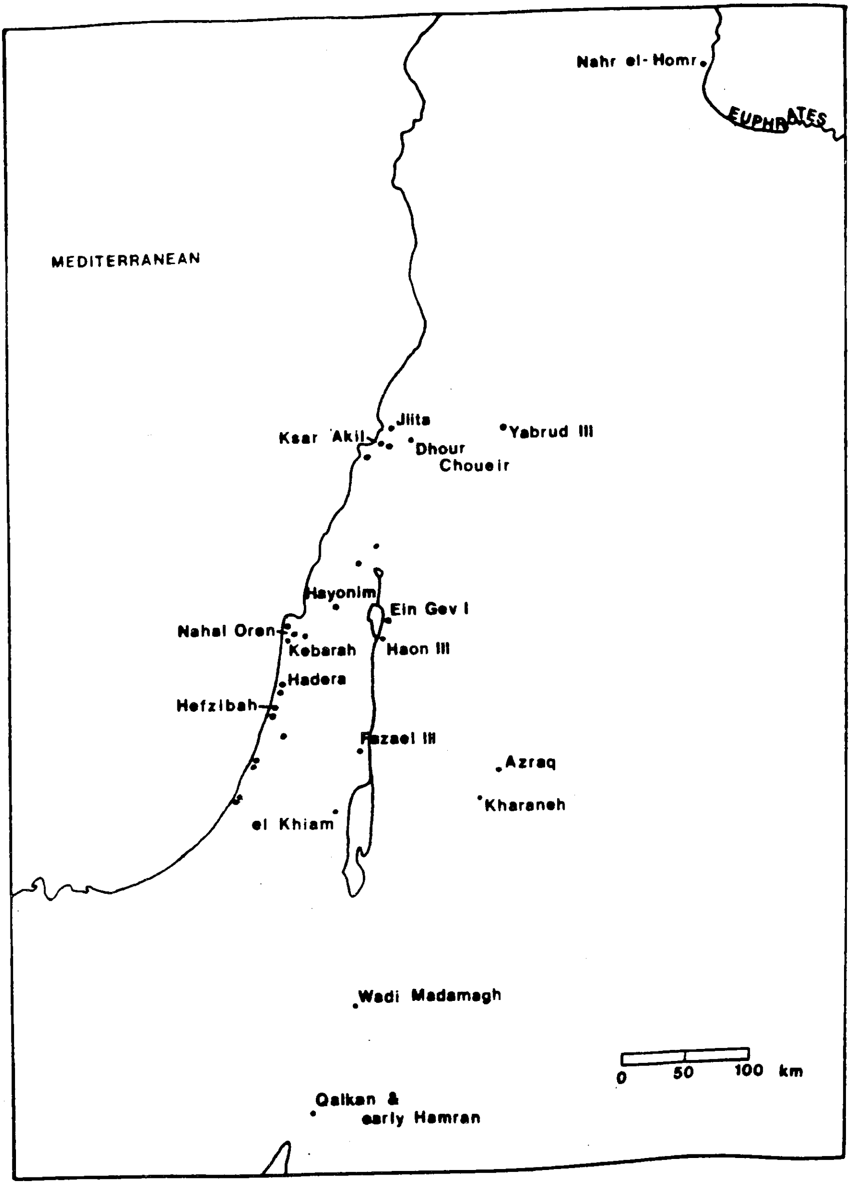


Figure 2. Distribution of Kebaran sites.

variety of other species was also used at Kebaran sites, although in much smaller numbers. These included pigs, hares, aurochs, and birds. Domestication of animals has not been established, although some researchers (Legge 1972; Saxon 1974) have suggested selective cropping or herding.

To date, none of the known Kebaran sites has yielded evidence of domesticated plants, with the possible exception of Nahal Oren Layer IX. Here, in an in situ context, according to the excavators, domestic emmer wheat and barley were found (Noy et al. 1973:93). That some usage of wild plants, notably wild cereals, acorns, vetches, grapes, and figs, occurred, is supported by three lines of evidence. The first of these is the presence of plant remains at sites such as Nahal Oren Layer IX (Noy et al. 1973:93),while the second consists of the finds of probable plant processing implements, for example, grinding and pounding tools, at En Gev I (Arensberg and Bar-Yosef 1973:201; Stekelis and Bar-Yosef 1965:182), Nahal Hadera V (Saxon et al. 1978:254), Hefzibah (Ronen et al. 1975:57), and Haon III (Bar-Yosef 1975:368). Reconstruction of the prehistoric vegetation through the analysis of pollen cores also contributes to the picture of potential plant food resources. It is difficult to estimate the importance of plant resources during the Kebaran since supporting evidence is lacking at so many of the sites. The fact that grinding and pounding implements occur in higher frequencies at later sites, for example, in the Natufian, suggests that while processed plant foods were consumed in the Kebaran, they were not yet a major portion of the diet.

The diverse resources exploited the different environmental zones in which Kebaran sites are located were undoubtedly responsible in great part for the industrial variability seen in the chipped stone tool assemblages from the various sites. Of course, stylistic preferences and chronological evolution probably also played a role. Overall, the Kebaran assemblages and site sizes point to mobile hunting and gathering groups, who occasionally returned repeatedly to certain favorable locations. This may be reflected by the presence of the six successive floors in the hut structure at En Gev I (Arensberg and Bar-Yosef 1973:201).

Geometric Kebaran A

The Geometric Kebaran A follows the Kebaran, and dates from approximately 12,500 to 10,500 b.c. (Bar-Yosef 1981:396-398). The chronological relationship of the Geometric Kebaran A to the Kebaran has been stratigraphically demonstrated at sites such as Abri Bergy (Copeland and Waechter 1968:33), Yabrud III (Rust 1950), Fazael III (Bar-Yosef et al. 1974:421), and Hefzibah (Ronen et al. 1975:58-63). In contrast to Kebaran industries, the major distinguishing typological characteristics of the Geometric Kebaran A are the presence of geometric microliths (triangles, rectangles and trapezes) in frequencies greater than 2%, less than 10% burins, and the continuation of the

Falita point in the form of microgravettes at some sites such as En Gev III (Bar-Yosef 1970a:172, 1970b:62). Other common tool types are scrapers on blades. Grinding and pounding implements are known from Haon III (Bar-Yosef 1975:369) and Hefzibah (Ronen et al. 1975:57). There are hut structures at En Gev III (Martin 1979:110). Site size tends to be larger than during the Kebaran, but still ranges from 25m2 to 400 m2 (Bar-Yosef 1981:396-398).

As during the Kebaran, the Geometric Kebaran A manifests several spatial and chronological divisions. The distinct industries include triangle dominated assemblages at En Gev IV and Nahal Oren Layer VII (Bar-Yosef 1976:84, 1981:396-398), trapeze/rectangle dominated assemblages at Hayonim Terrace, Fazael III, el Khiam Terrace Layers 8 and 9, Lagama North VIII, and Mushabi XVII (Bar-Yosef 1976:79-83), and a continuation of the Falita point tradition at En Gev III (Bar-Yosef 1970a:172). Trapezes become wider through time and sites with these microliths cluster in the southern Levant, for example , Ma'aleh Ziq (Goring-Morris 1978:272). Krukowski microburins outnumber regular microburins in the desert areas, as at Lagama North VIII (Bar-Yosef and Goring-Morris 1977:125).

In the central Levant, Hours (1976:123) suggests that the Geometric Kebaran A of Lebanon be renamed the Falitian, pertially because of its early recognition at Yabrud III, and partially because the evolution of the Kebaran and Geometric Kebaran A in the central Levant is different from developments to the south. The recent work by Henry (1982) in southern Jordan has also demonstrated the existence of an industrial complex related to the Geometric Kebaran A. He has identified this as the Middle Hamran (Henry 1982:431).

The expansion of Geometric Kebaran A groups into what are now desertic areas (northern Sinai, Negev and Syrian Deserts) and onto the Transjordanian Plateau, was prompted by a climatic amelioration which began slightly prior to 12,500 b.c. Evidence from cores taken in the Ghab and Zeribar and stratigraphic analyses points to the onset of moister conditions and the gradual expansion of tree cover and of enviromental zones such as the steppe (Bottema and van Zeist 1981:116-118; Endo 1978:79; Goldberg 1981:58-65; Leroi-Gourhan 1973:46; Shimada 1977:39). Geometric Kebaran A sites (Fig.3) are found in the coastal areas (Ashdod area, Hadera I and II), the Judean Hills (el Khiam), the Mt. Carmel area (Nahal Oren), the foothills of the Lebanon Mountains (Abri Bergy, Jiita II), the Galilee (Hayonim Terrace, En Gev III), the Anti-Lebanon Mountains (Yabrud III), the steppe (Wadi Rum, Nahr el-Homr, Douara Cave, Site 50, el Kowm, Jebel Hamra J201, J203), the Negev Desert (Ma'aleh Ziq, Nahal Lavan II, VI), the Jordan Valley (Fazael III), the Transjordanian Plateau (Ras En Naqb Basin), and the northern Sinai Desert (Mushabi XXI, Lagama IC, IF).

Geometric Kebaran A sites are more numerous than Kebaran period sites. They occur in a greater variety of

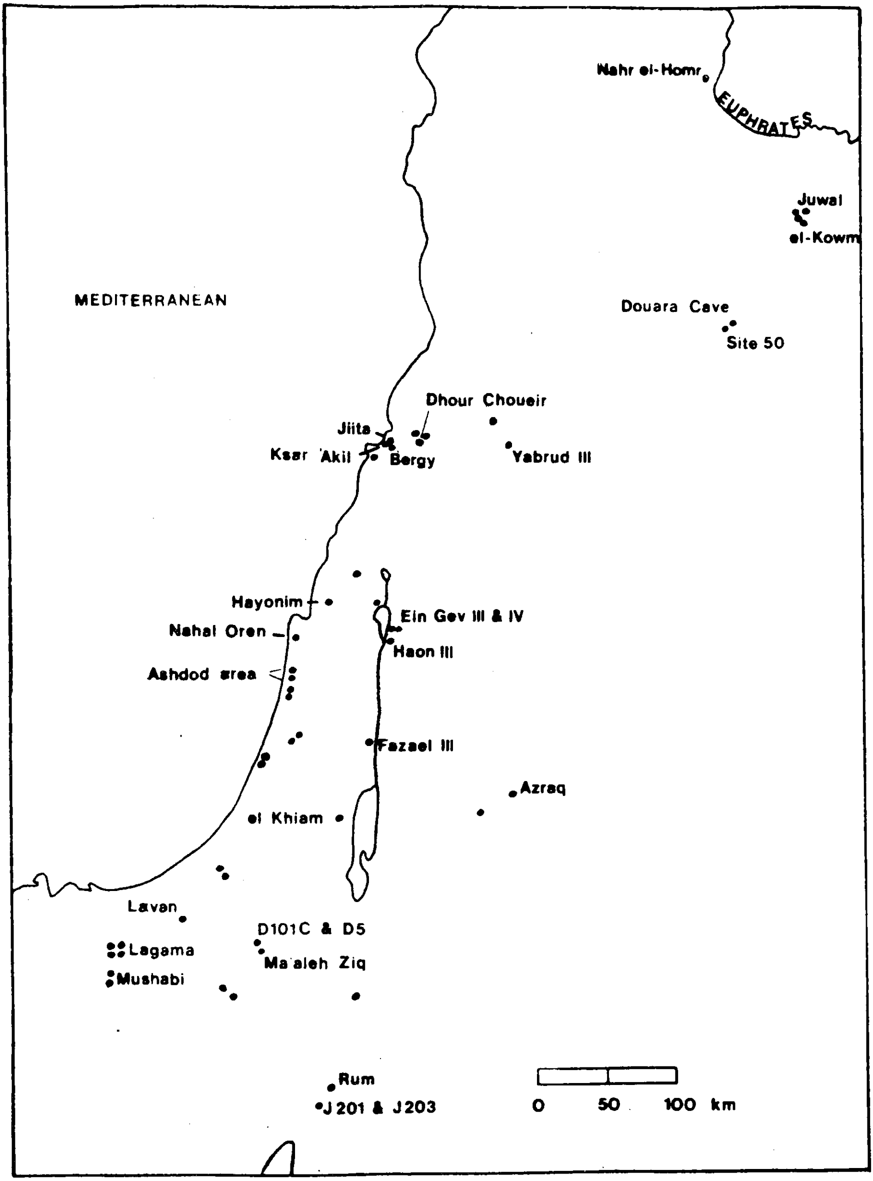


Figure 3. Distribution of Geometric Kebaran A sites.

environmental zones, and in greater numbers in some of these zones, over a shorter duration of time, 2,500 radiocarbon years, (compared to the Kebaran span of 4,500 radiocarbon years). This suggests that climatic amelioration favored both territorial expansion and perhaps population growth. However, the basic hunting-gathering pattern appears to have remained the same. Gazelle was still one of the favorite hunted species throughout Palestine, for example, at Nahal Oren Layers VIII and VII (Noy et al. 1973:90), and Hefzibah (Ronen et al. 1975:57), and onager at some of the steppic areas, as at Nahr el-Homr (Clason and Buitenhuis 1978:79). Goat was found at site D5 in the Negev (Marks 1976b:297), while fallow deer remained important at Ksar 'Akil (Hooijer 1961:Table 25; Tixier 1970:186). Little, if any, evidence exists concerning the use of plant foods during the Geometric Kebaran A. The presence of grinding and pounding tools at a few sites (Haon III, Hefzibah) suggests that some plant processing may have occurred, but it does not appear that processed plant foods were an important constituent of the diet.

The spatial and chrononlogical diversity among Geometric Kebaran A assemblages, like that seen during the Kabaran, is probably partially determined by differences in the quantity and type of available resources within each region. Thus, the wooded conditions found in the central Levant, at sites such as Ksar 'Akil, may have demanded, if not different hunting and collecting strategies, at least differences in scheduling and processing of resources. These differences would contrast with a steppic/desertic region such as the northern Sinai or Negev. In fact, many, although not all, of the steppic/desertic sites, such as Mushabi XIV,XVI (Bar-Yosef and Goring-Morris 1977:146) and D101C (Simmons 1977:127), appear to have been hunting camps, while those in other environmental zones, such as Haon III (M.-C. Cauvin 1981a:440), and Nahal Oren (Noy et al. 1973:95), exhibit more continuity of occupation.

Negev Kebaran

As its name implies, the Negev Kebaran is a manifestation confined to the Negev Desert (Fig.4). It was located by the Southern Methodist University surveys and excavations in the Har Harif area of the Negev Desert and defined by Marks (1977a, 1977b: Marks and Simmons 1977). There are two temporal phases in the Negev Kebaran. The earlier of these is the Harif phase, which is characterized by the microburin technique, backed and truncated bladelets, and backed bladelets (Marks 1977b:23). The later phase is the Helwan phase, characterized by Helwan lunates and multiple notched bladelets (Marks 1977b:23). Although there are no dates for the Negev Kebaran, Marks (1977b:23) believes the Harif phase to be contemporary with, and perhaps derived from, the Mushabian, while the Helwan phase is contemporary with the early Natufian.

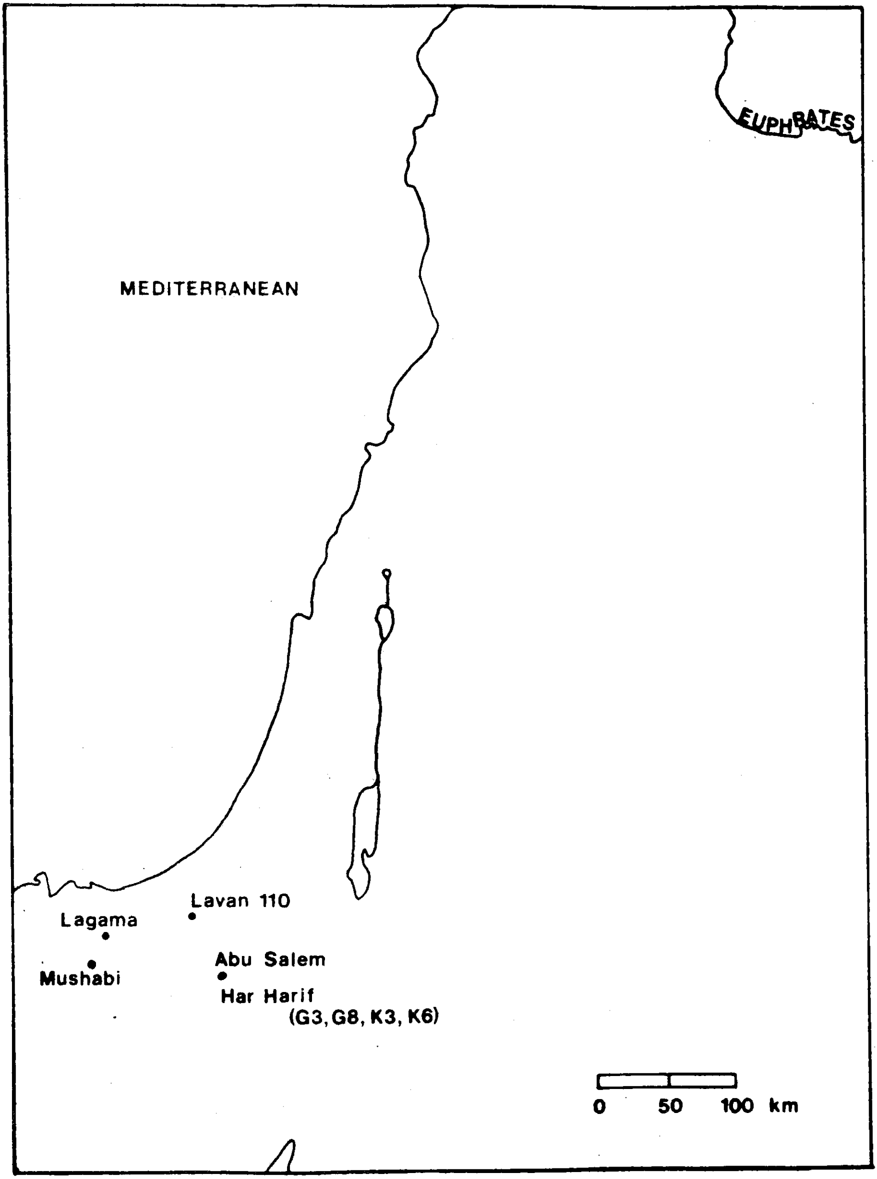


Figure 4. Distribution of Negev Kebaran, Mushabian and Harifian sites.

The eleven sites of the Negev Kebaren, including G3 and K6, appear to represent hunting camps (Marks 1977a:225, 1977b:24). The sites are located on the highest ground and water sources are not readily available. If the Negev Kebaran belongs to the same time period as part of the Geometric Kebaran A, then presumably it occurred during the climatic amelioration. This would seem to be supported by the fact that these sites are located in modern marginal areas, where a hunting-gathering economy presently would not be feasible. The sites are mainly surface concentrations so there has been no recovery of faunal or plant materials. Marks (1977a:225) has postulated that the Central Negev was a peripheral zone for this complex, although it is not clear where the main occupation area was located, unless one assumes that the Negev Kebaran phases represent activity facies of the Mushabian and the early Natufian. The Late and Final Hamran of southern Jordan also utilize the microburin technique and lunates (Henry 1982:431), although there is no clear connection with the Negev Kebaran.

Mushabian

The Mushabian (Fig. 4) is another steppic adaptation within the Geometric Kebaran A time range. However, the characteristics of the chipped stone assemblages point to an origin in northern Africa, with contact between northern Africa and the Levant facilitated by the expanded steppe regions into the Sinai Desert during the climatic amelioration (Bar-Yosef 1981:398; Phillips and Mintz 1977:183). The major characteristics of the tool assemblages include the extensive use of the microburin technique, La Mouillah points, and arched backed bladelets (Bar-Yosef 1981:398;Bar-Yosef and Phillips 1977:257-258). A few grinding tools and bone tools are present. Site size ranges from 25 M-2 to 200 M-2. There is some evidence that, at some sites, the Mushabian overlies the Geometric Kebaran A, the Mushabian appears to be, at least in part, stratigraphically later than the Geometric Kebaran A (Phillips and Mintz 1977:182).

Test excavations at in situ sites such as Mushabi V and XIV have revealed the remains of hare and gazelle, as well as juniper charcoal (Phillips and Mintz 1977:164, 170). The presence of juniper charcoal suggests either that this area was then forested or that forests were closer to this area than they are presently. This, in conjunction with site size and distribution, suggests that some Mushabian sites may have been hunting camps. Phillips and Mintz (1977:164) state, on the basis of site locations and hearth orientations, that these camps were seasonally used, representing both summer and winter occupations. Many ochre stained grinding and pounding implements have been found at Mushabian sites. This indicates that grinding and pounding implements were used for tasks other than processing plant foods.

The chipped stone component of the Mushabian sites shares may similarities with the Negev Kebaran, especially with the Harif phase, This has led Marks (1977b:23) to suggest that the Negev Kebaran is derived from the Mushabian. In the final analysis, however, it is clear that several industrial assemblages (Geometric Kebaran A, Negev Kebaran, Mushabian, and perhaps Late and Final Hamran) were used in the exploitation of a similar steppe environment. That the tool assemblages varied typologically and technologically suggests both cultural and chronollogical differences.

Natufian and Other Late Epipaleolithic Sites

The Natufian was first recognized by Garrod in 1928 at the site of Shukbah in the Wadi en-Natuf (Garrod 1942:1). Subsequent work at Mugharet el-Kebarah by Turville-Petre (1932) showed that the Natufian was stratigraphically later than the Kebaran. Recent work at Nahal Oren (Noy et al. 1973:83-84) and on the Hayonim Terrace (Henry and Davis 1974:195; Henry and Leroi-Gourhan 1976:394; Henry, Leroi-Gourhan and Davis 1981:35) further refined the sequence by defining Geometric Kebaran A levels directly below the Natufian levels. The Natufian and late Epipaleolithic C-14 dates bracket its duration in radiocarbon years from approximately 10,500 to 8,300 b.c. (Henry 1982:437; Haynes and Haas 1974:379; M.-C. Cauvin 1980:17).

The microlith remains a dominant hallmark of the chipped stone component. However, the predominant form during the late Epipaleolithic is the lunate, rather than triangles, trapezes, rectangles, or other forms. Other common chipped stone tools are borers and awls. Sickle blades are distributed throughout the Mediterranean zone (Bar-Yosef 1970a:176, 1981:398-402).

In contrast to the preceding Kebaran and Geometric Kebaran A period sites, Natufian sites exhibit a wide range of cultural artifacts other than chipped stone. Several sites have structures. Thus, for example, there is an architectural platform at Jericho (Kenyon 1981:271), stone walled huts at Ain Mallaha (Perrot 1961:544), Rosh Zin (Henry 1973a:129, 1973b:205-206), and the Hayonim Terrace (Henry et al. 1981:38), and a leveled bedrock area at Mugharet el-Wad (Garrod and Bate 1937:11-12). Grinding and pounding implements are also numerous, being found at sites in the Negev (Rosh Horesha, Rosh Zin), Mt. Carmel (Mugharet el-Wad, Nahal Oren), the Judean Desert (Erq el-Ahmar), and the Galilee (Ain Mallaha). Bone tools are another common artifact at some sites, for example, Mugharet el-Wad, Mugharet el-Kebarah, Ain Sakhri, Erq el-Ahmar, Hayonim Cave, and Ain Mallaha (Stordeur 1981:434).

The late Epipaleolithic sites in northern Syria also have some of these characteristics. There are circular hut pits at Tell Abu Hureyra, as well as grinding and pounding implements (Moore 1975a:116, 1979:62-63). Both Tell Abu Hureyra and Tell Mureybat have a variety of bone implements (Stordeur 1981:434).

The distribution, size and number of Natufian and other late Epipaleolithic sites (Fig. 5) may reflect three trends. First, the climatic amelioration which began prior to 12,500 b.c. reached an optimum in the southern Levant at about 10,000 b.c. (Sanlaville 1981:159). This resulted in an expansion of the forested and steppic zones in the southern Levant, which, in turn, permitted more intensive exploitation by prehistoric groups, especially in the steppic areas. Second, there was an increase in the number of sites over that known from the Geometric Kebaran A period. This may reflect a growth in population in the Levant. Third, several of the sites were larger than those in the preceding period (Ain Mallaha, Rosh Zin, Erq el-Ahmar). This suggests that settlement pattern now included larger or more intensively utilized sites (perhaps with larger populations).

Numerically, gazelle was the dominant exploited faunal species at many sites (Nahal Oren, Ain Mallaha, Rosh Zin, Mugharet el-Wad). However, depending upon the environmental zone in which a particular site was located, the emphasis on a particular species varied. Thus, goat was the dominant species at Beidha (Perkins 1966:66-67) and deer and pig were hunted in large numbers at Ain Mallaha (Ducos 1967:385). Other species utilized included fish, terrestrial molluscs, lizards, and turtles. Selective hunting, based upon the fauna available in a given environmental zone, appears to have been the pattern practiced by late Epipaleolithic groups. The suggestion by Legge (1972) and Saxon (1974) that this faunal exploitation was a form of herding has not yet been convincingly demonstrated.

There is little doubt that collected plant foods played an important role in Natufian subsistence strategy. Early investigators, such as Garrod, believed, on the basis of the presence of abundant ground stone implements and sickle blades, that plant foods, notably cereals, were domesticated. This indicated to them that the Natufians were the first agriculturalists (Garrod 1957:216). Research since Garrod's time has shown that, while there is evidence of the use of various plant foods, as at Nahal Oren (Noy et al. 1973:93), these are not morphologically domesticated.

On the other hand, Moore (1982:228) has suggested that the extreme abundance of wild einkorn at the late Epipaleolithic site of Tell Abu Hureyra indicates that einkorn was cultivated in this area of northern Syria. This cereal grass may have been harvested using techniques which did not alter the genetic structure of the wild einkorn.

Harifian

The Harifaian was located and defined by Marks and the Southern Methodist University research team in the 1970s (Marks et al. 1972:81-83; Scott 1977:271). It postdates the late Epipaleolithic, with C-14 dates falling into the time span from 8,500 to 8,000 b.c. at the type site of Abu

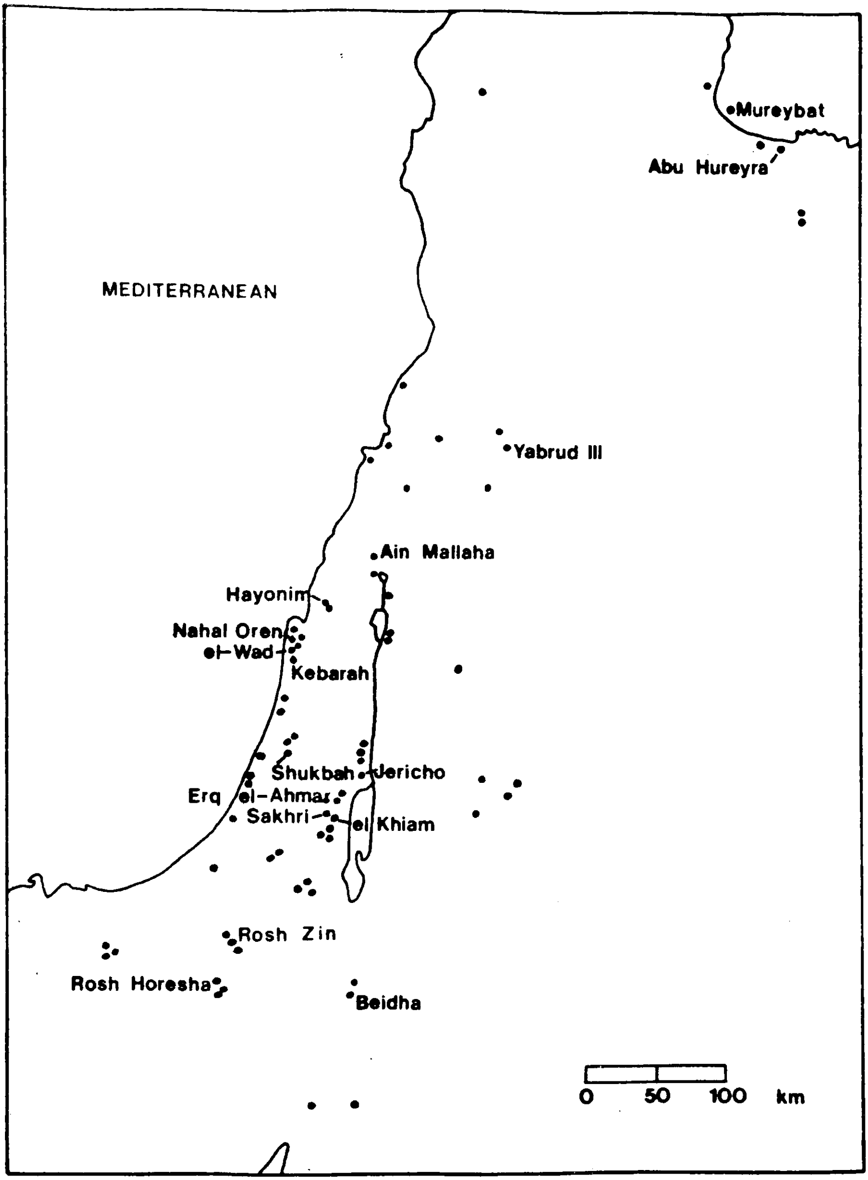


Figure 5. Distribution of late Epipaleolithic sites.

Salem (Scott 1977:271). It does not appear to be derived from the Natufian, although the two are probably related.

Characteristically, the Harifian chipped stone assemblages contain numerous microburins and scrapers, backed bladelets and blades, Harif points, Mushabi points, very small lunates and triangles, truncations, notches, and denticulates (Phillips and Bar-Yosef 1974:480; Scott 1977:284-285).

The distribution of the Harifian is restricted to the Central and Western Negev and the Northern Sinai (Fig. 4). Sites in the highlands of the Har Harif in the Central Negev (Abu Salem G8, K3) all have ground stone and/or structures, suggesting that some of them may have been base camps (Scott 1977:275-281). This is in contrast to the sites in the Western Negev (Nahal Lavan 110) (Phillips and Bar-Yosef 1974:480) and the northern Sinai (Lagama IV, Mushabi II, XX, XV) (Phillips 1977), which, based on their small size and the nature of the artifacts, were probably seasonal hunting camps.

The location of the Harifian sites in the semi-arid desert zones indicates that the climatic optimum reached during the late Epipaleolithic period continued to exercise an influence over the desert regions. Thus, animal and plant resources were still available to prehistoric hunting and gathering groups in these areas. Evidence from Abu Salem shows that both gazelle and goat were equally exploited, along with some onager, hare, tortoise, lizard, and rock partridge (Marks and Scott 1976:47; Scott 1977:282-284). Although no floral information is forthcoming, it is likely that some of the grinding implements were used to process plant foods, in addition to other substances such as ochre.

The location and contemporaneity of the Harifian with the early aceramic Neolithic (Proto-Neolithic and PPNA) suggests that it represents a variation of the early aceramic Neolithic of the central and northern Levant.

Early Aceramic Neolithic

The early aceramic Neolithic, including the Proto-Neolithic and the Pre-Pottery Neolithic A (PPNA), is contemporary with the Harifian and postdates the late Epipaleolithic. At sites such as Jericho, where the Proto-Neolithic and the PPNA were recognized by Kenyon (1959:150), and at Tell Mureybat (J. Cauvin 1972:108), the early aceramic Neolithic has been shown to lie stratigraphically above the Epipaleolithic deposits. Radiocarbon dates have suggested that this period began about 8,300 b.c. and continued until 7300 b.c. (Bar-Yoef 1980:127).

As its name implies, the early aceramic Neolithic represents an economic development, without ceramics, that is qualitatively different from the Epipaleolithic. The major chipped stone tool classes, while retaining many of the late

Epipaleolithic tools, emphasize other categories. Thus, arrowheads, adzes and axes, sickle blades, and borers and awls are common. Ground stone implements now mainly grinding slabs and rubbers rather than mortars and pestles, are frequent at these sites. Ground stone axes appear for the first time, although they are not common implements. Round huts or houses are found at Jericho, Tell Mureybat, Gilgal I, and other sites. Monumental architecture, in the form of a wall and tower, has been found at the site of Jericho (Kenyon 1981:6-7). Some sites, notably Jericho, are immense in size. There are also numerous small sites, for example, Nahal Lavan 108. Noticeably fewer sites are present during this period than during the preceding late Epipaleolithic. One important new trend seen during this time is the appearance in Levantine sites of obsidian from Anatolian sources. This suggests that informal trade from Anatolia into the Levant was occurring at this time.

The distribution of the early aceramic Neolithic sites (Fig. 6) shows that prehistoric groups continued to occupy many of the same environmental zones as they did during the late Epipaleolithic. If the Harifian sites are acknowledged as a variant of the early aceramic Neolithic, then early aceramic Neolithic sites are found in the Negev (Abu Salem, Nahal Lavan 110), the Sinai (Lagama IV, Mushabi XX), southern Jordan (Jebel Queisa), Mt. Carmel (Nahal Oren), the Judean Hills (el Khiam), the Jordan Valley (Jericho), the Anti-Lebanon (Nacharini), and the steppe (Tell Mureybat). The utilization of such a wide variety of environmental zones, plus the diversity seen in comparisons of assemblages from site to site, suggests that, as in the late Epipaleolithic, the early aceramic Neolithic may consist of several distinctive entities (Moore 1978:133. The delimitation of the Harifian is case in point.

The continued occupation of the presently marginal semi-arid zones of the Negev and Sinai Deserts suggests that while temperatures continued to rise, enviromental conditions were still favorable enough to allow exploitation of these areas. This would be especially true if strategies of resource procurement had altered since the late Epipaleolithic. Evidence for these altered strategies comes from the presence of domesticated cereals found at Tell Aswad, Jericho (Hopf 1969:356), and possibly Nahan Oren (Noy et al. 1973:92), and from indirect evidence such as site size, where large sites perhaps imply a semi-permanent, if not permanent, occupation. However, there is no reason to assume that wild cereals and plant foods were not collected in conjuction with domesticated varieties. This probably was the case at Tell Aswad, where a lush vegetation characterized the environs of the site (Moore 1978:149).

Faunal remains of wild species, gazelle at Nahal Oren (Legge 1972:121) and Jericho (Clutton-Brock 1971:54), fox, pig, onager and cattle at Jericho (Clutton-Brock 1971:54), goat and pig at Nahal Oren (Legge 1972:121), gazelle, cattle and wild ass at Tell Mureybat (Ducos 1975), are abundant. It is

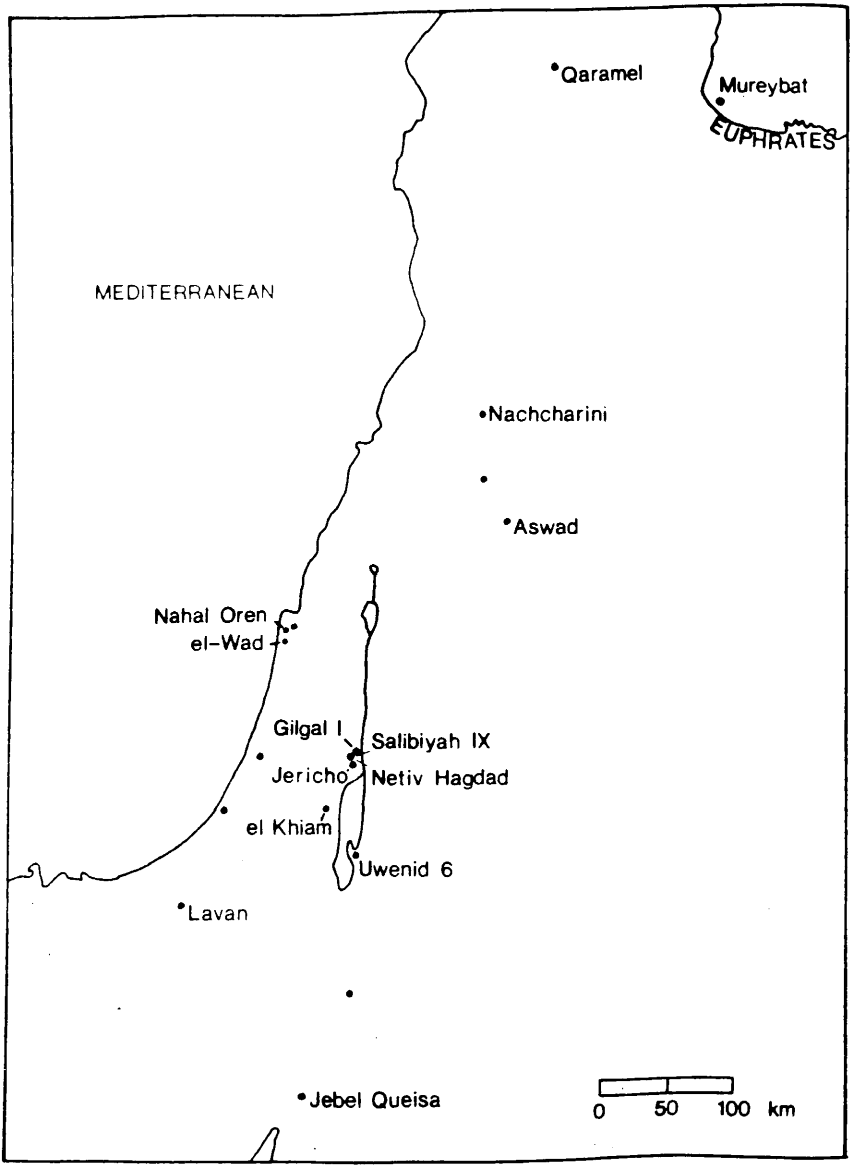


Figure 6. Distribution of early aceramic Neolithic sites.

evident, therefore, that hunting still played an important role in the economy of the early aceramic Neolithic.

Although the early aceramic Neolithic differs in many respects from the preceding late Epipaleolithic, one of its most interesting features is its demonstration of the continuity between the Epipaleolithic and Neolithic. Thus, while significant changes were occurring in the structure of settlements (the wall and tower at Jericho, massive settlements), in social organization (community effort to construct the wall and tower at Jericho), and in contact between different Near Eastern areas (obsidian trade), local resource procurement altered only slightly. Morphologically domesticated cereals appeared, but the procurement or utilization of morphologically wild animals continue to be an important aspect of the economy. The early aceramic Neolithic, with its own particular modifications on the Epipaleolithic way of life, was not the agriculturally oriented entity that characterized later ceramic Neolithic development.

Summary

The Epipaleolithic and early aceramic Neolithic periods include a wide diversity of cultural complexes. This is the result of both chronological and spatial variation. The Kebaran period includes, among others, the proto-, early and classic Kebaran of Lebanon, and four, as yet unnamed, clusters of the southern Levant. The Geometric Kebaran A has several assemblages, dominated by different geometric microlithic groups (triangles versus trapezes) and by groups with narrower or wider microliths. The Early Hamran of southern Jordan, the Mushabian of the Negev and Sinai, and perhaps the Negev Kebaran, also are coeval with the Geometric Kebaran A. The late Epipaleolithic is one of the few time periods that has not been definitively divided into regional groups. The early aceramic Neolithic has been subdivided into at least three groups, the Harifan, the Proto-Neolithic, and the Palestinian group, originally labeled the Pre-Pottery Neolithic A. Moore (1978:133) has suggested that further subdivisions are possible, with Tell Mureybat, and Nacharini being distinct from each other, and from groups in the southern Levant.

The information that has been obtained from archaeological sites in the Levant during the Epipaleolithic and early aceramic Neolithic is very diverse in quality and kind. This is a basic reason why the evidence for economy and for regional and chronological differences is difficult to assess within and between periods. Thus, for example, since the bulk of research on the late Epipaleolithic has been concentrated in the southern Levant, this has led most reseachers to use the term Natufian to refer to all Levantine nine late Epipaleolithic occurrences. This is in contrast to research, for example, on the Kebaran period, where several regional and chronological phases have been distinguished in both the central and southern Levant.

Another prime example of the disparity in the evidence currently available is the contrast between data recovered from excavation as opposed to surface collection. This is an important factor in the placement of the Negev Kebaran, an industry derived largely from surface collections. In this particular situation, there is a lack of faunal and macrobotanical remains, as well as material for radiocarbon dating. Thus, the relationship of the Negev Kebaran to the Kebaran must be assessed solely on the basis of the characteristics of the chipped stone assemblages.

An example of differences in the quality of recovery of evidence is that relating to the time during which a site was excavated. Early researchers, the majority working prior to WWII, employed excavation and recovery techniques that are no longer in general use. Thus, for example, excavations at Mugharet el-Wad and Mugharet el-Kebarah were conducted using arbitrary horizontal levels which ignored most changes in natural stratigraphy. This undoubtedly resulted in the masking of all but the most gross chronological changes in these assemblages. This contrasts with the detailed excavations at Ksar 'Akil and Jiita II, where minute changes in microlithic types through time, documented stratigraphically, have increased the understanding of the evolution of the Kebaran in Lebanon.

Despite the interpretive problems related to discrepancies in the data base, it is possible to see in the Levant, from 17,000 to 7,300 b.c., a slow and gradual change from economies based primarily upon hunting and gathering to those with increasing emphasis on plant food collection and manipulation. The climatic amelioration which began just prior to 12,500 b.c., and the local climatic optimum reached around 10,000 b.c., contributed significantly to the modification of human behavior by allowing the expansion of relatively favorable environmental zones, such as a moister steppe. This, in turn, permitted human exploitation and occasional settlement in areas which would otherwise have been marginal at best. Thus, the archaeological record documents the absence of Kebaran sites from the Negev and Sinai Deserts during a climatically cool and dry period, but the usage of both desert areas during subsequent periods. Of course, human behavior and culture are rarely the result of environmental dictates alone. At least part of the success of later cultural complexes, such as the early aceramic Neolithic developments, in the usage of the steppe, was due to an alteration in subsistence strategies, the so-called shift to agriculture.

This increasing dependence on plant foods is illustrated in the archaeological record by several lines of evidence. The presence of ground stone implements, while known from Upper Paleolithic context (Fazael X, Ein Aqev), appears to increase abruptly at sites beginning with the late Epipaleolithic period (Tell Abu Hureyr, Mugharet el-Wad, Rosh Horesha). Although these grinding tools may have been used for a variety of materials, for example, ochre, they probably were used primarily on plant foods. Plant remains recovered through flotation techniques, notably at Tell Abu Hureyra and Nahal Oren, show an abundant use of plant foods, including barley, emmer wheat, vetches, legumes, and figs. Storage facilities, such as the plastered silos at Ain Mallaha, also suggest the collection of plant foods. In addition, morphologically domesticated cereals appear at sites such as Jericho during the early aceramic Neolithic. This suggests that the use of plant foods must have been a common activity earlier in prehistory, otherwise, domesticated varieties would not have appeared until much later in the Neolithic sequence.

On the other hand, the pattern of faunal exploitation remained basically unchanged from the Kebaran through the early aceramic Neolithic. A variety of animals was hunted, but one species was always dominant at a given site. Thus, fallow deer and goat were the preferred prey at Ksar 'Akil during the Kebaran, gazelle at Mugharet el-Kebarah during the Kebaran, gazelle at Mugharet el-Wad and Nahal Oren during the Natufian, goat at Natufian Beidha, and gazelle at Jericho and Tell Mureybat during the early aceramic Neolithic. The preferred species was undoubtedly determined by the environment of the region in which a site was located. There are a few reserchers, notably Legge (1972) and Saxon (1974), who suggest that the gazelle were herded at least as early as the late Epipaleolithic, and probably as early as the Kebaran. However, supporting evidence for this form of domestication is still open to serious question.

The shift to economic strategies based largely on plant food collection and, possibly as early as the late Epipaleolithic, on plant food cultivation, ultimately led to changes in social organization and settlement size. The trend toward larger and more permanent sites is seen as early as the late Epipaleolithic (Rosh Horesha, Tell Abu Hureyra, Mugharet el-Wad, Ain Mallaha), although it has been argued (Perrot 1968: col. 389) that Ain Mallaha was a permanent site in a favorable environmental setting, whose inhabitants did not rely on plant cultivation. The establishment of large, and at least semi-permanent, sites culminated in the monumental architechture discovered in the Jericho early aceramic Neolithic. The construction of the wall and tower, a singular phenomenon at the moment, must have required considerable community cooperation. While it has been argued that the oasis situation of Jericho created a unique environment, and therefore, probably unique cultural developments, there is no evidence, aside from the wall and tower, to suggest that the lifestyle of the Jericho population was considerably different from that of other early aceramic Neolithic populations. These changes in social organization, settlement structure, and subsistence strategies eventually led to the full development of the Neolithic way of life.

CHAPTER 3

THE LATE EPIPALEOLITHIC OF THE NEAR EAST: NATUFIAN AND CONTEMPORARY CULTURES

The discussion of the Near Eastern late Epipaleolithic has been divided into Levantine and non-Levantine sections. The latter includes the Zagros foothills, the area near the Caspian Sea, and southeastern Turkey.

Historical Review of the Levantine Area

Because the research discussed in the following chapters is based primarily upon a late Epipaleolithic site in the northern Levant, the Levant is treated here in more detail than the non-Levantine areas. Included in this first section on the Levant are a summary of the historical development of archaeological research, an appraisal of the evidence for early plant and animal domestication, and a discussion of the late Epipaleolithic site affiliations. Three periods of archaeological research can be isolated in this area.

Early Research Period (1928-1940)

The late Epipaleolithic of the Levant, or what has been traditionally called the Natufian, was first discovered in 1928 at the site of Shukbah in the Wadi en-Natuf in the Judean Hills of Palestine by D. A. E. Garrod (1942:2). Garrod's excavations at Shukbah revealed a sequence of four layers, A through D. Layer A contained artifacts dating from the early Bronze Age to recent times, Layer B was later defined as Natufian, C consisted of redeposited archaeological materials, and Layer D was Levalloiso-Mousterian. This was the first discovery of an Epipaleolithic industry in the Levant in stratigraphic context. Layer B was characterized by small lunates with abrupt backing, backed and truncated blades, sickle blades, core scrapers, and a few triangles, plus the presence of burials, (Garrod 1932b:258). The abundance of the microlithic component and the types of microliths present, originally suggested to Garrod that this industry was derived from the Capsian of northern Aftica (Garrod 1957:211). However, this interpretation was soon modified by the discoveries in the Natufian layers at Mugharet el-Wad and Mugharet el-Kebarah.

The excavations at Mugharet el-Wad, on Mt. Carmel, south of Haifa, in Palestine, beginning in 1929, again revealed the existence of an Epipaleolithic layer (B) in a stratigraphic position below Bronze Age to recent deposits, and above the Upper Paleolithic of Layer C (Garrod 1932b:259-260; Garrod and Bate 1937:6). The Mugharet el-Wad Layer B materials, in conjunction with the earlier finds at Shukbah, led Garrod to define the Natufian as a culture with architecture, burials, portable art objects, ornamental objects, worked bone, ground stone tools, and a chipped stone assemblage characterized by microliths, predominantly the lunate (Garrod 1957:214-222). She suggested that this Epipaleolithic industry was a development peculiar to Palestine, and, therefore, not of north African (Capsian) origin (Garrod 1932b:261).

The analysis of the chipped stone component of Layer B enabled Garrod to propose a two-fold chronological division of the Natufian. The Lower Natufian found in lower Layer B (or B2) was characterized by a predominance of lunates and sickle blades with Helwan or "ridge-backed" retouch (formed by bifacial retouch along the back of the tool.) The sickle blades were roughly rectangular in shape. In addition, there were small numbers of massive picks and choppers, as well as round scrapers. Bone objects included points, harpoons, gorgets, pendants, and sickle hafts (Garrod 1932b:265). Burials were also present in this layer, as well as a leveled bedrock area on the terrace, a wall, and bedrock mortars.

The industry from upper Layer B (or B1), Upper Natufian, was marked by the presence of abundant abruptly backed lunates, some Helwan backed lunates, abundant microburins, sickle blades, and backed and truncated blades. A few picks and massive scrapers were present. Bone tools included only a few bone fragments (Garrod 1932b:261; Garrod and Bate 1937:32-33). Layer B1 also had a few burials. Working without the benefit of modern C-14 dating techniques, Garrod provisionally dated the Natufian at 4,000 to 5,000 b.c. (Garrod 1932b:268).

By 1931, Turville-Petre had located a third stratigraphically intact Natufian layer at the site of Mugharet el-Kebarah (Turville-Petre 1932:271). In fact, Turville-Petre found two layers with distinct Epipaleolithic industries, Layer B (Natufian) and Layer C (Kebaran). This further refined the relative space dating sequence of the Natufian by showing that it was later than the beginning of the Epipaleolithic period. The layer B Natufian from Mugharet el-Kebarah was Lower Natufian in character.

Beginning also in 1928 and continuing, with some interruptions, for a period of twenty years, René Neuville investigated a series of sites in the Judean Desert (Neuville 1951). Some of these sites,Erq el-Ahmar, Tor Abu Sif, Ain Sakhri, El-Khiam, and Oumm ez-Zoueitina, contained Natufian deposits. Neuville placed the industries from his Judean sites in Garrod's Lower and Upper Natufian classification, and, in addition, proposed a four-fold division of the Natufian (Neuville 1934). In general, his Natufian I corresponded to Garrod's Lower Natufian, and Natufian II to the Upper Natufian. The Natufian I industry was found at Erq el-Ahmar A-2, Ain Sakhri, and Oumm ez-Zoueitina. Natufian II industries were found at Tor Abu Sif and el-Khiam B-2. The assemblages of Natufian III and IV contained arrowheads, which are now known to be one of the hallmarks of the Neolithic.

One site with late Epipaleolithic deposits outside of the Palestinian area was excavated in the early 1930s by Rust (1950). This was the site of Yabrud III in the Anti-Lebanon. Here, Rust located a late Epipaleolithic layer above what is now known to be Geometric Kebaran A (Falitian). Nine of the fifteen geometric microliths, mainly lunates in the Natufian layer, had Helwan retouch (Rust 1950:119).

Four important points were made during the early period of research into the late Epipaleolithic. First, both Garrod and Neuville believed that they had found not only a new Epipaleolithic industry, the Natufian, but also the first appearance of agriculture. In particular, they believed that the abundant sickle blades were proof of agriculture (Garrod 1932b:258, 1957:216). They also felt that the Natufians continued to rely on hunting. This was supported by the faunal remains at most sites. For example, at Mugharet el-Wad, Bate (1932:278) found abundant remains of gazelle. Although the faunal remains from the Judean Desert sites and from Shukbah were somewhat impoverished, gazelle and goat were found in the Judean Desert (Vaufrey in Neuville 1951:210, 214-215), and gazelle at Shukbah (Bate in Garrod 1942:19).

Garrod and Neuville both proposed chronological divisions of the Natufian. These schemes were based on observable differences in the chipped stone assemblages, and primarily upon Gerrod's work at Mugharet el-Wad for the Upper and Lower designations (Natufian I and II), and upon Neuville's work in the Judean Desert for Natufian III and IV.

Stratigraphic positioning at Shukbah, Mugharet el-Wad, Mugharet el-Kebarah, Erq el-Ahmar, el-Khiam, and Yabrud III established the Natufian and late Epipaleolithic as later than the other Epipaleolithic industry, the Kebaran, which Neuville had classified as Upper Paleolithic VI.

Finally, Garrod's ideas on the origin on the Natufian shifted from the view that it was related to the Capsian of northern Africa, to the view that it was a culture indigenous to Palestine, and confined in its distribution to the Palestinian area (Garrod 1957:211).

Middle Research Period (1940-1965)

The period from the early 1940s to the mid-1960s saw a number of important discoveries. The Natufian was again located in stratigraphic context below modern remains and above Middle Pateolithic remains at the site of Abu Usba (Stekelis and Haas 1952:18). Here, the Natufian industry was named the Usbian, since the industry of Layers B1 and B2 apparently contained pottery. It now appears that the layers were mixed and the pottery should be viewed as intrusive. The chipped stone industry, on the other hand, was characteristically Natufian. There were lunates, some of which had Helwan retouch, microburins, sickle blades, and scalene triangles (Stekelis and Haas 1952:21; Henry 1973b:109).

Following the Second World War, research on a large scale was resumed. Stekelis and Yizraely began an excavation at Nahal Oren in 1951 (Stekelis and Yizraely 1963). Although this site contained a sequence from the Upper Paleolithic through the Pre-Pottery Neolithic, interpretation was complicated by the fact that the site was on a large terrace slope where cultural layers were not horizontally deposited. However, a typical Natufian chipped stone assemblage along with numerous bone artifacts (gorgets, sickle hafts, harpoons, and awls), and ornamental objects, was found.

By the mid-1950s Perrot had began his excavation of Ain Mallaha, located on the west bank of Lake Huleh. This was an extensive open air habitation site with three distinct Natufian levels. Based on a preliminary analysis of the chipped stone, it was felt that the Natufian industry was uniform throughtout the occupation of Ain Mallaha, and that Ain Mallaha represented a form of the Lower Natufian (M.-C. Cauvin 1966:489; Perrot 1966:479). The extensive settlement at Ain Mallaha, numerous ground stone implements, and abundant faunal remains led Perrot to believe that Ain Mallaha had been a permanent settlement, and that subsistence was based primarily on hunting and gathering, rather than upon agriculture (Perrot 1961:546).

Perhaps one of the most significant discoveries of the Natufian was that made by Kenyon at Jericho in the late 1950s. Working from the information derived from earlier excavations by Garstang (1935), she located three distinct aceramic Neolithic layers (Proto-Neolithic, Pre-Pottery Neolithic A and Pre-pottery Neolithic B). Directly below a thin layer of the Proto-Neolithic in Square E, she found a deliberately created platform structure in association with Natufian remains, a lunate and barbed bone point (Kenyon 1981:271-273). Carbon 14 dates obtained by the then new radiocarbon dating method (solid carbon) yielded dates of 7,800 ± 240 b.c. (F-69) and 7,850 ± 247 b.c. (F-72) (Kenyon 1959:5-9). A more recent determination using a gas counter yielded a date of 9,140 ± 90 b.c. (BM1407) (Kenyon 1981:272).

An eastward extension of the distribution of the Natufian was seen in the discovery of a Natufian deposit at the site of Beidha, in Jordan, by Kirkbride (1966). Although the chipped stone assemblage has not been fully described, it is believed to belong to the Lower Natufian horizon, with Helwan retouched implements (lunates and blades), microburins, core scrapers and truncated blades.

The site of el-Khiam in the Judean Desert was re-excavated by Gonzalez-Echegaray (1964, 1966). Although none of the levels was designated as Natufian, it is possible that levels 7 through 5, and perhaps level 4, on the basis of chipped stone types, fall within the limits of Natufian assemblages. There is some question as to the adequancy of the stratigraphic control during this excavation, and the usage of Western European typological names for certain tools, for example, Azilian points, makes direct comparisons with Levantine industries difficult.

Hayonim Cave was also excavated during this period. Natufian deposits were found in both the interior and terrace areas (Bar-Yosef and Tchernov 1966:105; Henry 1973b:84. The chipped stone included Helwan lunates and sickle blades, as well as a high frequency of burins and nongeometric microliths.

This period of research into the Natufian both confirmed some of the beliefs that early investigators had held, and raised serious questions concerning other aspects of the early ideas. Research at these sites further confirmed the stratigraphic position of the Natufian, as well as yielding the first absolute dates for this time period. Even using the old solid carbon method, C-14 dates showed the Natufian to be of significantly greater antiquity than Garrod had provisionally thought.

The importance of hunting was again underlined by the abundant faunal remains at Ain Mallaha, Hayonim Cave, and Jericho; and, this period of investigation caused some, notably Perrot, to cast doubts on the unequivocal acceptance of agriculture as a basis of Natufian life. Perrot felt that certain favorable localities, such as that of Ain Mallaha, would permit permanent settlement based on hunting, fishing, and collection of plant foods.

Although the early chronological division of the Natufian by Garrod and Neuville did appear to have validity, it assumed a certain homogeneity among Natufian assemblages. This assumption was indirectly challenged by Perrot when he stated that he had a "form" of the Lower Natufian at Ain Mallaha. He based this observation on the low percentage of microliths at Ain Mallaha compared to other known Natufian sites. The excavations at Hayonim Cave also supported the notion of variablility within Natufian assemblagees. Geometrics were present in only small quantities, but burins appeared in high frequencies.

Finally, the discovery of a Natufian layer at Beidha expanded the known distribution of Natufian sites to the high jebel east of the Jordan Rift Valley.

Recent Research Period (1965-1985)

The period of recent research has been characterized by a variety of work on the late Epipaleolithic in the desert areas, in areas beyond Palestine, and by detailed examinations of variablility both chronologically and spatially. The number of known Natufian and other late Epipaleolithic sites has been greatly augmented. The re-excavation of Nahal Oren (Noy et al. 1973) aided in firmly establishing the Kebaran through Pre-Pottery Neolithic B sequence. The excavators attemped to recover both faunal and plant remains; however, the preservation of plant remains at Nahal Oren was poor. Even with the aid of modern flotation techniques, few specimens were recovered. In what the excavators state is an in situ context, a few grains of domesticated barley and wheat were found in the Kebaran layer (Noy et al. 1973:93). The presence of later agricultural period deposits (PPNA and PPNB) and the probable presence of rodent activity at the site adds to the question regarding the in situ claim. However, if the context of the domesticated grain finds is indeed indisputable, then it suggests that agriculture was known as early as the Kebaran, and therefore, should have been known during the late Epipaleolithic.

Many new Natufian sites have been located. One of these is Fazael IV in the Jordan Valley, which is Late Natufian according to the excavator (Bar-Yosef et al 1974:423). Two large Natufian settlements were located in the Central Negev. These are Rosh Horesha (Marks and Larson 1977) and Rosh Zin (Henry 1973a, 1976). Both of these sites are probably late in the Natufian period, based on C-14 dates of 8,930 ± 280 b.c. (SMU-10) and 8,540 ± 430 b.c. (SMU-9) from Rosh Horesha (Henry and Servello 1974:36). The northern Negev has yielded two Natufian surface sites in the Yatir region, Ira 10 and 22 (Valla and Bar-Yosef 1978:90; Valla, Gilead and Bar-Yosef 1979a:131-133, 1979b:225-229). The Natufian has also recently been found farther south than Beidha in southern Jordan (Henry 1982:437), in the Azraq Basin of Jordan, at Azraq 18 and Kharaneh (Garrard and Stanley-Price 1975-1977), in the Black Desert of Jordan (Betts 1982), and at the Hayonim Terrace (Henry and Leroi-Gourhan 1976).

To the north of Palestine, in the Lebanon area, the late Epipaleolithic period is known from only a handful of sites. These include Jiita II (Chavaillon and Hours 1970), Jiita III (Besançon, Copeland and Hours 1975-1977:44), Borj Barajne (Copeland and Wescombe 1965:129), and Saaide II (Schroeder 1970:199-200). In Syria, recent research has exposed late Epipaleolithic deposits at Tell Mureybat Ia (J. Cauvin 1974:47), Taibe (M.-C. Cauvin 1973) Tell Abu Hureyra (Moore 1975b, 1979), and the el-Kowm area (J. Cauvin, M.-C. Cauvin and Stordeur 1980; M.-C. Cauvin 1981a), Nacharini (Besançon et al., 1975-1977:44), and surface remains at Dibsi Faraj East (Wilkinson and Moore 1978).

With the increase in the number of known Natufian and other late Epipaleolithic sites, there has been a greater recognition of both spatial and temporal variablility, One of the markers used originally by Garrod to separate the

Lower and Upper Natufian was the use of the microburin technique. Investigation into this aspect has led some researchers to state that the microburin technique is not a good choronolgical indicator since it varies both temporally and spatially (Bar-Yosef and Valla 1979:148). For example, the microburin technique is known to have been used earlier than the Natufian (Yabrud III 7-5, En Gev IV), and to vary in the intensity of its usage from heavy use in the southern Levantine desert areas to light usage in the northern Levant.

The relative frequency of Helwan retouch as an indication of the temporal stage of the late Epipaleolithic has also undergone some revision. While this trend is apparently valid for the Palestinian sites and those from southern Jordan, Helwan retouch has been found only in small quantities in northern Syria during the late Epipaleolithic time period.

One trend that does appear to be universal throughout the Levantine area during this time period is the reduction in the length of lunates through time (Valla and Bar-Yosef 1979:146; Valla 1981:97). This appears to be true even for the northern Syrian region, where the very late assemblage of Tell Mureybat Ia has very small lunates, ca. 15 mm. long on the average (M.-C. Cauvin 1980:13). It is clear that a good framework of absolute dates will be needed before these temporal differences in the industries can be understood.

The research period beginning in about the mid-1960s and continuing up to the present has modified earlier views on the Natufian, and has raised several new research questions. This new knowledge can be summarized under six major points. First, the value of the presence of the microburin technique in site assemblages as a chronological indicator has proved to be minimal. Microburin technique varies both spatially and temporally.

The relative abundance of Helwan retouch as a chronological indicator, while valid for sites in Palestine and southern Jordan, does not seem to apply in northern Syria. The tend toward decreasing length of lunates through time apparently holds true for all of the late Epipaleolithic Levantine sites, from southern Jordan to northern Syria.

The observed variability within Natufian assemblages is not solely related to changes through time. It also appears to be the result of site location, at least in terms of environmental zone (mountain, steppe, hills). Late Epipaleolithic sites have been discovered in previously undocumented areas, filling in the blank areas in the spatial extent of these industries.

Finally, continuing research on the question of plant domestication has led some reseachers (Moore 1978, 1982) to suggest that late Epipaleolithic period peoples practiced cultivation. However, Perrot (1968) and J. Cauvin (1978) believe that semi-permanent to permanent villages during this period were the result of collection of wild plant foods and of hunting.

Discussion of Domestication

Plant Domestication

In order to comprehend the circumstances relevant to the question of plant domestication during the late Epipaleolithic time period, it is first necessary to understand the environmental and climatic conditions existing at that time. Evidence from pollen cores at Lake Zeribar, Iran, and the Ghab Valey, Syria, presents a very generalized picture of overall conditions in the Near East in this period. The Zeribar core shows an increase in arboreal pollen accompanied by an increase in temperature and annual precipitation, from 12,000 to 8,500 b.c. (Bottema and van Zeist 1981:118; van Zeist 1969:43; van Zeist and Bottema 1977:81). This eventually resulted in the establishment of a steppic forest in that region. The summers were drier than today, but since dry summers do not affect cereals and legumes, these plants would have been able to expand into that region after 12,000 b.c. (van Zeist 1969:43).

The Ghab Valley pollen core also shows an expansion of the forest in that region, including _Quercus_, _Pistacia_, _Olea_, and _Ostrya_, after 10,000 to 9,000 b.c. (Bottema and van Zeist 1981:118; Niklewski and van Zeist 1970:752-753). New research on a deep core from Lake Huleh in Israel, by Tsukuda, supports a similar climatic amelioration in the Levant from 12,000 to 8,000 b.c. (Bottema and van Zeist 1981:116). In all probability, the major non-desertic environmental zones, i.e. Mediterranean forest, open forest, and steppe, were much more extensive in the Levant during the late Epipaleolithic time period than today (Moore 1978:Fig. 2; Aurenche et al. 1981:580, Fig. 1).

At the end of this period, Natufian sites in the Negev Desert (Rosh Horesha and Rosh Zin) show 5-7% arboreal pollen, including _Pinus halepensis_, _Pistacia_, _Olea europaea_, _Acacia_, and _Quercus calliprinos_. However, the period from 10,000 to 8,000 b.c. in the Negev was one of progressively drier Mediterranean climate than had existed during the Geometric Kebaran A from about 12,000 to 10,000 b.c. (Golberg 1981:65; Horowitz 1976:67, 1979:343). This drying trend by the end of the late Epipaleolithic period is also documented in the central and northern Levant, at Hayonim Terrace in Israel (Leroi-Gourhan 1980:90, 1981:108; Henry and Leroi-Gourhan 1976:405), and at Tell Mureybat Ia, Syria (Leroi-Gourhan 1974:444, 1980:90).

Of course, this general pattern found in the near East is in reality much more complex when viewed in detail for any particular region. Unfortunately, with the exception of samples of pollen and plant remains from archaeological sites, which are in some part culturally selected by the activities of prehistoric groups, a detailed picture of specific areas within the Levant has yet to be synthesized.

The location of sites of food collectors within the various environmental zones, Mediterranean forest, open forest, and steppe, is generally assumed to be oriented to maximize the exploitation of the resources of a given area, or of an ecotonal border (Vita-Finzi and Higgs 1970:5). Thus, sites located in or near the forested areas would be close to sources of nuts, fruits, roots, and cereal grasses, and localities frequented by animal species favored in hunting. The majority of Natufian sites found in central and northern Palestine, for example, Hayonim Cave and Terrace, Ain Mallaha, and Mugharet el-Wad, are in such a locale. Sites such as Mugharet el-Wad and Mugharet el-Kebarah are also within easy access of the coastal plain, which prehistorically would have been wider due to lower sea level during the late Epipaleolithic period. Both Tell Mureybat and Tell Abu Hureyra, although located in steppic environments, are along the Euphrates River, which allowed exploitation of riverine resources, as well as those of the steppe.

With the expansion of the Mediterranean and steppe environmental zones during the late Epipaleolithic, the natural distribution of the wild cereals, einkorn, emmer, and barley, was probably also more widespread, especially since, in modern times, they are often associated with oak-parkland forest (Harlan and Zohary 1966:1076, 1079). The natural distribution of the wild wheats and barley is based, of course, on the assumption that their modern distribution accurately reflects their prehistoric habitat preference.

Barley was one of the most important of the early cereals since it had a wide distribution around the "Fertile Crescent," and included several distinct races. Wild barley is known to grow in dense stands in its primary habitat in the deciduous oak woodland belt, where it would have probably been noticed and utilized by prehistoric groups. Barley is also a natural component of the steppe and desert wadi bottoms (Harlan and Zohary 1966:1076-1077).

Wild einkorn shares much of the same distribution as barley, but is not found in Palestine (Harlan and Zohary 1966:1078). Wild emmer is found in the Taurus-Zagros Arc and in the Levant. Two distinct races exist. One is found in sporadic and thin stands in Turkey, Iraq and Iran, while the other is found in massive stands in the Upper Jordan Valley (Harlan and Zohary 1966:1079).

The evidence from archaeological sites indicates that prehistoric groups during this period made extensive use of a wide variety of plant foods. Two factors are responsible for the present evidence of plant foods available to archaeologists. These are differential presevation and recovery techniques. With adequate preservation, flotation recovery can produce good results, but this technique has only recently been employed. Thus, at Nahal Oren, with poor preservation conditions, flotation produced only twenty-five seeds (Noy et al. 1973:93). These included cereal grasses, vetches, and vines. The most abundant plant food data comes from the results of flotation recovery at the site of Tell Abu Hureyra. Here, wild einkorn was found in large quantities. Vetches and morphologically wild lentils were also recovered. A few grains of morphologically domesticated barley, along with the lentils, are considered intrusives from the overlying Neolithic layers (Hillman in Moore 1975b:72-73). Fruits of the caper tree, turpentine tree and hackberry bush were also present.

In addition to the evidence provided by macrobotanical remains, pollen analyses have also revealed the presence of other plant food species. At Rosh Horesha in the Negev Desert, 9% cereal pollen was found (Horowitz 1979:250). Rare cereal pollen was reported in 1974 in Phase I from Tell Mureybat (Leroi-Gourhan 1974:445). Since then, actual grains of wild einkorn have been identified at Tell Mureybat (J. Cauvin 1978:20). The direct evidence of plant food use is thus confined at present to a handful of sites. This evidence, when examined in detail, shows the plant species to be morphologically wild.

The indirect evidence for the use of plant foods consists of the presence of sickle blades and grinding tools at many late Epipaleolithic sites, although it is difficult to demonstrate that they were used primarily to obtain and process foods. Studies of dental wear, however, have suggested that stone ground plant foods played an important role in the Natufian diet (Smith 1972:237).

While data consisting of actual plant remains from archaeological sites have been available for less than two decades, different ideas and models of where agriculture first appeared and how this development took place were proposed almost from the beginning of research on the late Epipaleolithic period. These ideas can be grouped under several major themes.

First, are those claims for the first appearance of agriculture based on artifactual data alone. Garrod's views (Garrod 1932b, 1957) are representative of this point of view. She felt that the presence of sickle blades and ground stone implements, as well as architecture and burials, indicated that the Natufians were sedentary. Thus, they no longer relied on a hunting and gathering round, but, instead, practiced agriculture in conjunction with some hunting.

A second view was proposed by Braidwood (1958). He suggested that early agriculture would be found in the hilly areas of the Taurus-Zagros Arc (the so-called Fertile Crescent), because this was, assuming no post-Pleistocene climatic change, the presumed natural distribution area of the wild cereals. While sedentary village sites with evidence of agriculture have indeed been found in this area, for example, Jarmo, this clear evidence of agriculture post-dates the late Epipaleolithic.

Binford (1968), stimulated by the work of Boserup (1965), postulated a model opposed to Braidwood's ideas. Boserup had proposed that increased population led to an intensification of agricultural practices. Using this idea, Binford suggested that population was an independent variable in the development of agriculture. He believed that prehistoric dependence on coastal resources led to sedentism which led to an increase in population. Therefore, when the coastal areas were reduced in size by rising sea levels, and larger populations had to be supported by wild plant resources in more restricted areas, prehistoric groups were forced to move to more marginal areas, outside of the natural distribution area of the wild cereals. They were forced to deliberately grow plants they had brought with them from the optimal areas.

Binford's model can be criticized on several points, The use of coastal and aquatic resources was not a development restricted to the post-Pleistocene in the Near East; it had occurred earlier in prehistory. The level of sedentism necessary to produce a rapidly increasing population is not archaeologically evident until the late Epipaleolithic at the earliest, and then only at selected sites, such as Ain Mallaha, Mugharet el-Wad, Rosh Horesha, Hayonim Terrace, Tell Mureybat, ann Tell Abu Hureyra (all large habitation sites). Of these, only Nahal Oren is sufficiently close enough to the coastal area to be relevant to Binford's hypothesis. In addition, there is no archaeological evidence that suggests that populations were forced to move to more marginal areas, or that if they did so move, that they brought plants from the natural distribution area with them. Finally, given the areal distribution of late Epipaleolithic sites, it is unlikely that the "marginal" areas were devoid, or nearly so, of inhabitants. This would have made a population movement into marginal areas from optimal areas difficult.

During the debate over the location of and the causes for the orgins of agriculture, there were a few researchers, such as Perrot (1968), who believed that when and if sedentism was proposed for late Epipaleolithic sites, this did not indicate that these settlements practiced agriculture. Rather, these sites, such as Ain Mallaha, were located in environmentally favorable locations that allowed their inhabitants a degree of sedentism, but with an economy based on collection of wild plants and on hunting. This idea was later taken up by J. Cauvin (1978) who saw the late Epipaleolithic era as one of primitive sedentary villages, such as Tell Mureybat, whose inhabitants practiced a collecting and hunting strategy.

Cauvin's ideas regarding the origin of sedentism are representative of another main theme. He suggested that agriculture was a product of sedentary life; and that sedentism arose from sociodemographic factors before the development of agriculture. He saw a recognition of the social benefits of sedentary life by hunter-gatherers as the causal factor for sedentism. This model has also been espoused by Bender (1975) and Hassan (1977). While it is not inconceivable that some prehistoric groups may have perceived social benefits that could be derived from sedentary settlement, this hypothesis is not testable archaeologically.

A final theme is characterized by the work of Moore (1975, 1978, 1982), who has suggested that the man-plant relationships evidenced during the early Epipaleolithic were gradually intensified, so that by the late Epipaleolithic, prehistoric groups were practicing cultivation of morphologically wild grains, at least at some sites, Moore's model is based upon earlier suggestions by Higgs and Jarman (1969, 1972) and Jarman (1972), who had proposed that a close symbiotic relationship between man and plants and animals had existed perhaps as far back as the Mousterian. The intensification in the use of plants, or what Moore has called cultivation, would not necessarily result in morphological changes in the structure of plant foods. Thus, seemingly wild plants could actually be deliberately grown and harvested.

The key to morphological change appears to rest in large part on th harvesting techniques employed. If cereal stands were shaken or beaten to obtain the grains when these ripened, the plants with a brittle rachis would yield their grains more readily than plants with a tough rachis. The brittle rachis plant, which is morphologically wild, would thereby be the plant selected for by this harvesting technique. The presence of abundant grain, and the absence of sickle polish is strong archaeological evidence in support of this harvesting technique at Tell Abu Hureyr. Hillman (in Moore 1975b:72) also suggests several other factors influencing the morphological change from wild to domesticated forms. These include field rotation frequency, duration of fallow, the extent of crossbreeding with local wild populations, and the frequency and intensity of the production of mutant alleles for domestic characters. The evidence from Tell Abu Hureyra shows both an abundance of wild type einkorn, and the presence of weedy plants indicative of disturbed soils (Moore 1978:69).

While this cultivation model appears to have merit, it is based primarily on evidence from one site. However, this is the only site from which abundant primary plant evidence is available, so that the model proposed by Moore is the only model to utilize extensive primary evidence. Only when flotation retrieval is used in future excavations at late Epipaleolithic sites with favorable presevation, can the information from Tell Abu Hureyra be placed in a broader perspective.

The currently available data concerning the origins of agriculture during the late Epipaleolithic period point to at least two possible situations. First, plant utilization probably differed in different environmental zones. Thus, sites found in the Mediterranean forest zone may have primarily been oriented toward plant foods other than cereals, for example, items such as acorns or fruits. This may be indicated also by the presence of numerous mortars and pestles, The sickle gloss on sickle blades may relate to activities other than the harvesting of cereal grains, especially if, as Moore (1982:229) points out, cereals would have been less abundant in the climax Mediterranean forest vegetation. Sites located in steppic environments, where forest clearance would not have been a major factor, may have relied more exclusively on the cereal grains, as is suggested by the plant remains from Tell Abu Hureyra, as well as the presence of querns and rubbers.

Second, it has become increasingly apparent that the documentation of early agriculture may not reside in the presence of morphologically domestic cereal grains. Studies by Hillman (1978) have suggested that plant populations can retain morphologically wild characteristics for perhaps several centuries of cultivation. Thus, future research on this question will increasingly have to consider aspects of site location, availability of potentially arable land, abundance and types of plant foods, as well as settlement type and edgewear analyses of the tools presumed to have been used in cultivation.

Animal Domestication

Most of the major faunal species exploited by prehistoric groups during the late Epipaleolithic were widespread in the Middle East (Uerpmann 1981:103). Animal species preferring a forest environment included Sus scrofa (wild pig), Cervus elephus (red deer, Dama mesopotamica (Mesopotamian fallow deer), Capreolus capreolus (roe deer), and Bos primigenius (auroch). Steppe dwellers such as Equus hemionus (onager) and several species of Gazella (gazelle) also were present. The wild goat (Capra aegragrus) frequented areas characterized by rocky slopes.

Faunal remains from late Epipaleolithic sites show that the major exploitation pattern was a concentration on a single animal species. Thus, most Palestinian Naṭufian sites were characterized by high percentages of gazelle, 83.3% at Nahal Oren (Noy et al. 1973:90), 85.3% at Rakefet (Saxon 1976:191), 44.6% at Ain Mallaha (Ducos 1967:386), and 48.7% at Mugharet el-Kebarah (Saxon 1976:191). Gazelle also predominated at Hayonim Cave (Bar-Yosef and Tchernov 1966:129), Shukbah (Bate in Garrod 1942:19), Hayonim Terrace (Henry and Leroi-Gourhan 1976:402), and were found at Rosh Horesha (Marks and Larson 1977:197, Rosh Zin (Henry

1976:320), and Fazael IV (Bar-Yosef et al. 1974:423).

A variety of other species were utilized to a lesser extent at these sites. These included fallow deer, wild boar, roe deer, aurochs, red deer, antelope, fox, wolf, hare, squirrel, large lizards, tortoise, birds, and fish. Sites in locations with more broken topography often had a high percentage of goat, as for example, Beidha (Perkins 1966:66). Goat was also known from Rosh Horesha (Marks and Larson 1977:197) and Rosh Zin (Henry 1976:320), and from Erq el-Ahmar and el-Khiam (Vaufrey in Neuville 1951:210-215). Onager and gazelle were imporant species at Tell Abu Hureyra (Moore 1982:227), while the Wadi Judayid in southern Jordan had wild ass, aurochs, gazelle, sheep, and goat (Henry 1982:437).

It has been suggested by Legge (1972) and Saxon (1974) that the intensive exploitation of gazelle during the late Epipaleolithic represents a form of husbandry or herding. They have based their model on the ratio of immature to adult individuals, implying that higher percentages of young indicate highly controlled culling of herd populations. For example, the 54.7% of immature gazelle at Nahal Oren (Noy et al. 1973:90) is considered to be a result of husbandry.

Husbandry or herding would probably not be conducive to generating morphological change that would be visible osteologically. In this sense, the herding model is analogous to the model proposed by Moore for early plant cultivation. Both must depend on evidence other than observable differences in morphology between wild and domesticated forms.

At the moment, the herding model is more difficult to support than the plant cultivation model. Studies of modern gazelle herds have suggested that the faunal evidence from archaeological sites during the late Epipaleolithic period does not support the herding model. Simmons and Ilany (1975-1977:273) point out that gazelle herds are small, that gazelle are not gregarious animals, and that high percentages of immature gazelle may simply imply selective hunting patterns. Thus, at present, there is no very strong evidence that gazelle were domesticated or even herded.

It can be suggested that the practice of culling young animals existed regardlesss of the species exploited. From this viewpoint, the fact that goats were later domesticated may be only coincidentally related to earlier hunting strategies that selected for immature animals. The only animal known to be domesticated in the late Epipaleolithic, on the basis of morphological characteristics, is the dog, found at Ain Mallaha and Hayonim (Davis and Valla 1978).

Discussion of Site Affiliations

It is clear that late Epipaleolithic groups throughout the

Levant practiced specialized hunting of particular animal species. Recent large scale recovery of macrobotanical remains has suggested that the cultivation of cereal grains occurred in northern Syria, at Tell Abu Hureyra, and perhaps at Tell Mureybat. Other areas, particularly those in the Natufian heartland of Palestine, appear to have engaged in plant food subsistence strategies that were not primarily concerned with plant cultivation. If differences between northern Syria and Palestine existed in basic subsistence patterns, these differences may, in turn, reflect more fundamental cultural differences that can be discerned in the artifactual remains found in the two areas.

To date, there has been a great reluctance on the part of most researchers investigating the late Epipaleolithic to assign site assemblages to complexes other than the Natufian. For example, M.-C. Cauvin (1981b:440), summarizing the opinions of a recent colloquium, has suggested that the Natufian has a cultural unity that subsumes regional differences in the Levant. In this view, subdivisions can be distinguished, such as "Natufian of the Euphrates." However, such a point of view with an emphasis on uniformity may obscure important variability.

An example of this assumption of uniformity is seen in Stordeur's (1981) study of bone artifacts. Her assumption that all Levantine sites are Natufian leads her to propose centers of bone artifact production within this single culture. These centers, Mt. Carmel, the Judean Desert, the Galilee, and the Syrian sites, are each located in environmentally distinct areas. Alternatively, it is possible to interpret these "centers" as areas in which different types of bone implements were required for the exploitation of food resources. Thus, harpoons, bipoints (gorgets), and curved hooks at the Mt. Carmel sites may relate to exploitation of coastal resources. The sickle hafts found here and in the Galilee may be related to the gathering of plant resources found in the Mediterranean forest or in the coastal and interior swamps. Sickle hafts were not common at the Judean Desert sites, where the terrain was significantly less forested and few swamps were present. The Syrian sites have only bipoints, which may be associated as arrowheads, with the exploitation of faunal resources (A. Moore, personal communication 1983). The ornamental objects, oval pendants, pierced and truncated phalanges, and the art objects, are more difficult to explain. They appear at the Palestinian sites, but not at the northern Syrian sites. Thus, they may be either an indicator of cultural differences between Palestine and north Syria, or a factor related to the absence of burials at the north Syrian sites.

The reluctance to create entities which are not labeled Natufian can be traced to several historical factors. The Natufian was the first recognized Epipaleolithic culture in the Levant. Early work was mainly confined to the Palestinian area, and thus it was not difficult to use the

Natufian definition to cover similar industries found in areas immediately adjacent to Palestine. Thus, sites from diverse regions were included until the Natufian label was assigned to all cultural developments in the Levant during the late Epipaleolithic period.

Another factor is that most of the major sites upon which the definition of the Natufian is based were excavated at a time when artifactual, faunal, and macrobotanical recovery techniques were not as sophisticated as they are today. Thus, deep stratigraphic layers were excavated as single cultural units, as at Mugharet el-Wad and Mugharet el-Kebarah. This has served to mask evolutionary developments within artifactual assemblages and perhaps within faunal and plant assemblages as well. A definition which has been derived from potentially lumped chronological assemblages, as is the case with the Natufian "type" assemblages, makes comparison of assemblages difficult, if not impossible. This is because the composition of these assemblages can combine temporal, stylistic or developmental differences, environmental changes, and different activities.

With this caution, the following section (and subsequent chapters) will treat the relationships between the Natufian of Palestine and contemporary cultures in northern Syria. Figure 7 provides a distribution map of late Epipaleolithic sites in the Levant.

The Natufian <u>Sensu</u> <u>Strictu</u>

The Natufian culture, as originally defined by Garrod (1932b, 1942, 1957; Garrod and Bate 1937), comprised several major elements. These included the presence of abundant lunates, notably those with Helwan retouch, abundant sickle blades, a rich bone artifact industry, ground stone tools, architectural features, and some massive chipped stone tools such as picks. As mentioned earlier, Garrod was able to distinguish differences in the chipped stone assemblage through time at Mugharet el-Wad. She separated a Lower Natufian, characterized by higher frequencies of Helwan retouch, sickle blades, and massive tools, accompanied by a rich bone industry, from an Upper Natufian, in which abrupt retouch predominated, microburins were abundant, and the bone industry was less impressive.

The definition has been, with some additions and modifications, the foundation for all subsequent interpretations. Bar-Yosef (1970a) has pointed out that other common items in Natufian assemblage are perforators and burins, while Henry (1937b:162) states that although flakes predominate in the debitage, many blade cores (pyramidal) are characteristic.

Since sites from diverse environmental settings, spanning several hundreds of years, and excavated by vastly different techniques, are placed in the Natufian culture, it is not

Figure 7. Detailed distribution of late Epipaleolithic Sites.

1. Tell Dhahab
2. Nahr el-Homr
3. Tell Mureybat
4. Dibsi Faraj East
5. Tell Abu Hureyra
6. Aarida 7
7. el-Kowm
8. Jiita II and III
9. Antelias
10. Beruit Sands (Borg Borajne & 8II)
11. Saaideh
12. Nachcharini
13. Yabrud III
14 Mugharet el-Abde
15. Jiye I
16. Amiq II
17. Saidnaya
18. Qornet Rharra
19. Ain Mallaha
20. Hayonim Terrace and Cave
21. Sefunim
22. En Gev IV
23. Nahal Oren
24. Abu Usba
25. Mugharet el-Wad
26. Mugharet el-Kebarah
27. Rakefet
28. Taibe
29. Caesarea Sands
30 Kefur Vitkin III
31. Poleg 18M
32. Gath Rimon
33. Shukabah
34. Fazael IV and VI
35. Salibiyah I
36. Ala Safat
37. Jericho
38. Khanna
39. 14/7 (Black Desert)
40. Azraq
41. Kharaneh
42. Kefar Darom 28
43. Erq el-Ahmar
44. Umm Qala'a
45. Ain Sakhri
46. el Khiam
47. Oumm ez-Zoueitina
48. Tor Abu Sif
49. P508
50. Beer Faher
51. Halutza 5, 82, 83
52. Tulmeh
53. Kurnub
54. Nahal Lavan IV
55. Nahal Lavan 110
56. Rosh Zin
57. Matred 190
58. Lagama sites
59. Mushabi sites
60. Rosh Horesha
61. Arif en Naga
62. Beidha
63. J2
64. 406a
65. Khirdib el Filleh

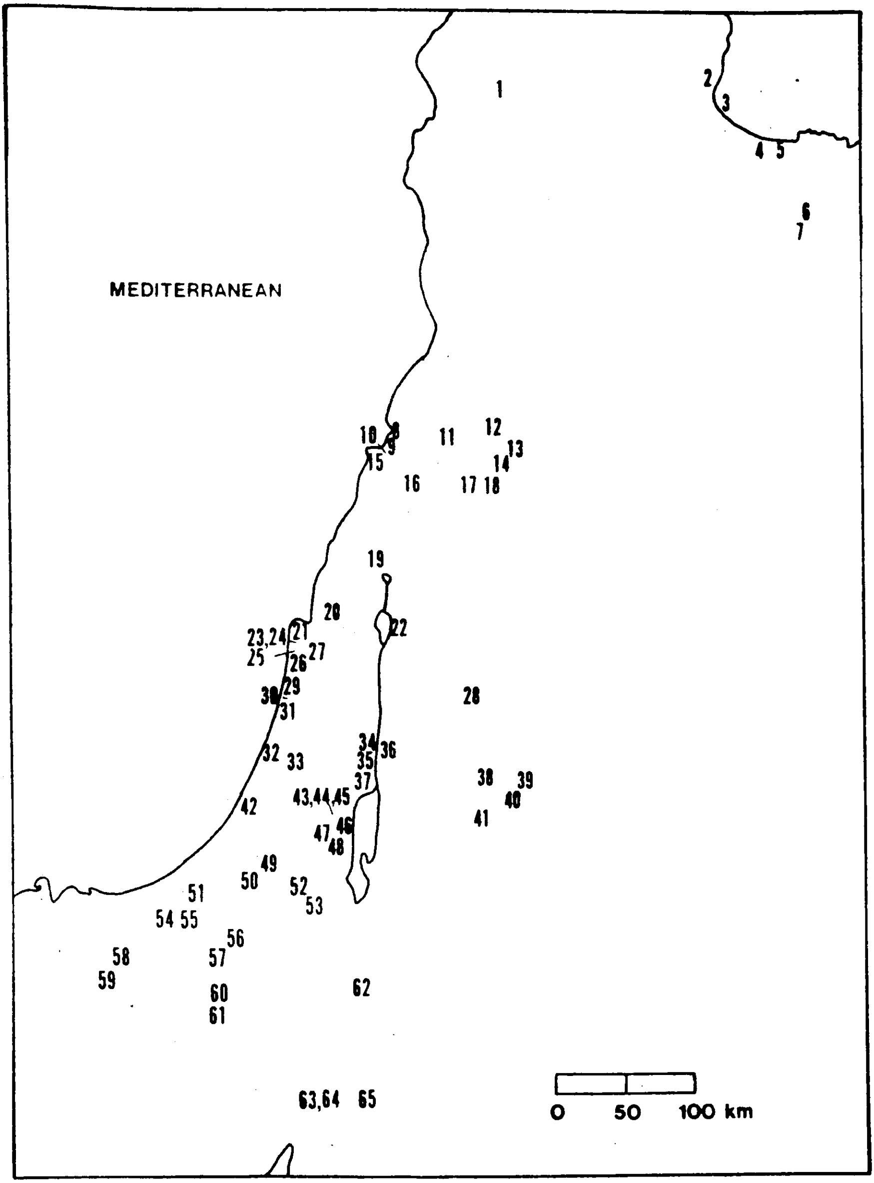


Figure 7. Detailed distribution of late Epipaleolithic sites.

surprising to find well documented variability within the assemblages described as Natufian. Thus, for example, burins range in frequency from 28.7%-31.4% at el-Khiam (Gonzalez-Echegaray 1966:96) and 24.0%-35.5% at Hayonim Cave (Bar-Yosef and Tchernov 1966:114), to 2.3%-3% at Mugharet el-Wad (Garrod and Bate 1937:33.36), 2.7% at Shukbah (Garrod 1942:12), and 0.9%-4.9% on the Hayonim Terrace (Henry and Leroi-Gourham 1976:397). Burins have been associated with the working of bone by both engraving and smoothing (Stafford 1977). Given that the Natufian is characterized by a rich and varied bone industry, one might expect that many Natufian sites, especially those with abundant bone artifacts, would have relatively high frequencies of burins. There is considerable discrepency in this relationship, with sites such as Mugharet el-Wad and the Hayonim Terrace, having abundant bone industries, but low frequencies of burins, while others like Hayonim Cave, have many burins and abundant bone artifacts.

Two possible explanations can be suggested. On the one hand, it is doubtful that Garrod's excavation and recovery success at Mugharet el-Wad was as meticulous as modern excavations. It is possible that her workers did not produce many burins, although a search on Garrod's backdirt did not porduce many burins, (A.J. Jelinek, personal communication 1983). Alternatively, although the assemblages from Hayonim Cave and the Terrace have been described separately in the literature, there is no reason at present, to assume that Natufian groups at the sites did not utilize the cave and the terrace simultaneously. Thus, the high percentage of burins from the terrace assemblages may reflect intrasite activity, with burin use, perhaps on bone, occurring within the cave. The fact that many Natufian sites have 10-20% burins (Table 3) suggests that burin distribution should be more closely controlled within the site before being used as an indicator of site variability.

Henry (1973b, 1977) has attempted to explain variability during the Natufian in three ways. He believes that one kind of variablility results from different activities in different environmental zones. While this is not an unreasonable assumption, especially if differential access to similar resources can be demonstrated, his three tool kit subclusters (Table 4) only partially demonstrate his hypothesis. Tool kit A includes two sites excavated by Garrod. Given the early date of excavation, and the fact that both were done by Garrod, it is possible that this subcluster reflects biases in recovery techniques rather than the activity and environmental setting.

Subcluster B consists of four sites (Henry 1977:238), all of which, except Abu Usba, are located within a hilly and steppic environment. Therefore, they are different on a macro-environmental scale from the Mediterranean forest, hilly topography, coastal access sites. However, Abu Usba is in exactly the same environmental zone as Mugharet el-Wad

Table 3. Burin percentages at various Natufian sites.

Site Name	% Burins	Source
Mugharet el-Wad B2	2.3	Garrod and Bate 1937:35-36
Mugharet el-Wad B1	3.0	Garrod and Bate 1937:32-33
Nahal Oren VI	8.9	Valla 1981:72-73 and British Museum collection
Nahal Oren V	8.3	Valla 1981:72-73 and British Museum collection
Mugharet el-Kebarah B	2.3	Collections from Pitt-Rivers, Cambridge, and British Museums
Ain Mallaha III-IV	14.2	Valla 1975:4, Table I
Ain Mallaha III	13.3	Valla 1975:4, Table I
Ain Mallaha Ib	10.7	Valla 1975:4. Table I Hayonim
Cave Interior	24.0	Bar-Yosef and Tchernov 1966:114
Hayonim Cave Exterior	35.5	Bar-Yosef and Tchernov 1966:114
Hayonim Terrace D	2.8	Henry and Leroi-Gourhan 1976:397
Hayonim Terrace C lower	3.6	Henry and Leroi-Gourhan 1976:397
Hayonim Terrace C middle	2.1	Henry and Leroi-Gourhan 1976:397
Hayonim Terrace C upper	4.9	Henry and Leroi-Gourhan 1976:397
Heyonim Terrace B	0.9	Henry and Leroi-Gourhan 1976:397
Rosh Horesha	12.4	Marks and Larson 1977:208
Rosh Zin	10.5	Henry 1976:333-335
el Khiam 7	26.6	Gonzalez-Echegaray 1966:96
el Khiam 6	28.7	Gonzalez-Echegaray 1966:96
el Khiam 5	12.6	Gonzalez-Echegaray 1966:96
el Khiam 4	12.8	Gonzalez-Echegaray 1966:96
Shukbah B	4.2	Garrod 1942:8-10
Black Desert 14/7	2.2	Betts 1982:80
J2 (Wadi Judayid)	1.2	Henry 1982:433
406a	0	Henry 1982.433

Table 4. Tool Kit subclusters from analysis by D. Henry (1977:237).

Tool Kit	Sites	Environment	Tools
A	Mugharet el-Wad B1 Mugharet el-Wad B2 Shukbah B	hilly topography, drier biotope, coastal access	high frequency of geometrics, moderate frequencies of backed pieces, sickle blades, low frequencies of scrapers, burins, notches, perforators
B	Rosh Zin Rosh Horesha Erq el-Ahmar Abu Usba	forest/steppe, steppe	high frequency of geometrics, moderate frequency of backed pieces, high frequency of burins, moderate to low frequency of of sickle blades, low frequencies of perforators, variable frequency of scrapers and notches
C	Hayonim Cave interior Hayonim Cave exterior	inland mountain topography with Mediterranean forest	low to moderate frequency of geometrics, moderate frequency of backed pieces, notches, and scrapers, high frequency of burins, low frequency of sickle blades

subcluster A) and only 2-3 km. away from Mugharet el-Wad. Henry explains this anomaly by calling Abu Usba a transitory camp. This suggests that the Abu Usba assemblage reflects variability that is not related to environmental zone, but rather to either activity focus, as Henry points out, or to factors related to the mixed character of the assemblage (discussed earlier).

Subcluster C is in reality only one site (Hayonim Cave). As mentioned before, it is not reasonable to assume that the interior and exterior areas of a cave represent two separate occupations, unless one can demonstrate temporal differences by means of stratigraphy or C-14 dates. Even so, the presence of different percentages of different types of tools between the two areas could be explained by the different activity loci in qualitatively different areas of the site. Although Henry describes the habitat as an inland mountain topography with a Mediterranean forest cover, the Hayonim area is also within thirteen kilometers of the coast, if the wadis Izhar and Yassaf are used as a route of travel (Bar-Yosef and Tchernov 1966:104). This distance would fall within the two hours' walking time used by Vita-Finzi and Higgs (1970:7) as a measure of site catchment and is about the distance of Shukbah from the coastal plain given the width of the coastal plain. Therefore, the Hayonim area also had some access to the coastal resources enjoyed by the tool kit A sites.

Both Bar-Yosef (1970a) and Henry (1973b, 1977) have suggested that some variablility may be explained by differences in activities occurring at base camps versus exploitative camps. Base camps have been defined as those with architectural features, ground stone implements, a full range of chipped stone tool types, burials, a rich bone industry, and abundant marine molluscs (Bar-Yosef 1970a:177). All of the larger Natufian settlements (Rosh Horesha, Rosh Zin, Ain Mallaha, Nahal Oren, Hayonim Terrace, Mugharet el-Wad, and Beidha), as well as several of the smaller sites, such as Shukbah and Erq el-Ahmar, have been classified as base camps. Transitory or exploitative camps according to Bar-Yosef and Henry, would include Mugharet el-Kebarah, Abu Usba, Rakefet, Fazael IV, and Tor Abu Sif.

The assumption of different site types appears to be justified. However, the majority of Natufian sites have tool kits with the full range of tool types represented. This occurs even at small surface sites such as 14/7 (Black Desert) (Betts 1982:80). The location of 14/7 appears to preclude its use as more than a hunting camp. In addition, architecture is not present at every site classifed as a base camp, for example, Erq-el-Ahmar, which Henry (1973b:176) states is a base camp. In fact, the base camp designation appears to be applied, regardless of meeting the criteria of the definition, to any medium to large sized site. Thus, large sites become base camps and small sites become exploitative camps.

Henry's (1973b, 1977) other category of variablility in Natufian assemblages is due to temporal changes. This aspect of variablility has been the most thoroughly investigated explanation. Garrod (1932a, 1932b) and Neuville (1934) were among the first to suggest that differences in assemblages related to time, when they were able to distinguish between Lower (I) and Upper (II) Natufian.

The relative frequency of Helwan retouch in Natufian assemblages has continued to be a relatively accurate chronological indicator. Thus, for example, recent test excavations at Wadi Judayid, with C-14 dates (uncalibrated) of 10,140 ± 800 b.c. 10,800 ± 1,000 b.c. and 10,834 ± 659 b.c., has yielded a lunate assemblage with 50% Helwan retouch (Henry 1982:437), similar to the Layer B2 Lower Natufian at Mugharet el-Wad (Garrod and Bate 1937:32-36).

Other proposed indicators of chronological placement, such as the microburin technique, are now considered too variable both temporally and spatially to be of use as a chronological indicator (Bar-Yosef and Valla 1979:148). However, Henry (1974) has suggested that the microburin technique is primarily geographical in its distribution, which may indicate that this technique is a stylistic mode of blade segmentation. The largest concentration of sites with microburin technique is in the area south of Palestine. Henry believes that, over time, this technique spread with varying successs to more northern areas. Both extreme southern Levantine industries, Mushabian and Negev Kebaran, show high microburin indices prior to the Natufian period. It can be argued that if the Helwan phase of the Negev Kebaran is contemporary with the early Natufian, then the microburin technique is not absent from the extreme southern Levant during the Natufian, as Bar-Yosef and Valla (1979:148) suggest. The only site with levels predating the Natufian, and with microburins, in an area other than the extreme southern Levant, is En Gev IV. At present, there is no explanation for this apparent anomaly.

If the microburin technique is both a chronological and geographical phenomenon then one would expect that the presence of this technique could be a chronological indicator for central and northern Palestinian sites. This appears to be the case, with the microburin technique appearing in the central area of Palestine at Tor Abu Sif, Mugharet el-Wad B1, Nahal Oren VI,V, and Fazael IV during the Late to Final stages of the Natufian (Valla 1981:97).

There is one important exception to this pattern, the Hayonim Terrace, where the industry of Layer D has a high frequency of both microburin technique and Helwan retouch. Oddly enough, here the microburin technique decreases in frequency through time (Henry and Leroi-Gourhan 1976:398, Table 2). On the basis of the published stratigraphic profiles of the Hayonim Terrace (Henry and Leroi-Gourhan 1976:394, Fig 3), it apppears possible that Layer D is not a discrete unit. It may be that the artifacts from Layer D to some extent represent a mixture from Layers C and E, especially since Bar-Yosef and Tchernov (1966:105) report that the Hayonim terraces were ploughed and damaged to a depth of 60-80 cms. Since the precise context of the carbon sample yielding the C-14 date of 9,970 $\pm$ 90 b.c. in Layer D is not stated, this may be from material associated with the Layer E Geometric Kebaran A occupation rather than with the Natufian of Layers D and C. Thus, assuming that the Layer C industry is later than the earliest stage of the Natufian, and that the C-14 date from Layer D could represent at least a composite date from Layers E and D, the appearance of the microburin technique may not be as early as it otherwise appears.

Even the association of the microburin technique with the Helwan style retouch is not surprising. Helwan retouch occurs throughout most of the 10th millennium, for example, at Mugharet el-Kebarah, Ain Mallaha, Mugharet el-Wad, Hayonim Terrace, and Wadi Judayid (Table 5). A sporadic acceptance of the microburin technique in central and northern Palestine, even if this did not occur until after the first phases of the Natufian, would, in some cases, coincide with the presence of Helwan style retouch.

Recent work (Bar-Yosef and Valla 1979; Valla 1981) has suggested that, using mean length, lunates early in the Natufian sequence are longer than lunates from later assemblages. This general trend appears to be valid, judging from the sequence at Ain Mallaha(IV-III-II:22.28 mm., Ic: 17.50 mm., Ib: 13.47 mm.). However, it must be noted that the separation of the Natufian into three phases by Valla (1981:97, Table 7) is in reality more dependent on the relative frequency of Helwan retouch for the first two phases than upon length of the lunate (Table 6). Thus, the early Natufian lunate lengths range from 19.46 mm. at Mugharet el-Wad B2 to 28.28 mm. at Beidha, The middle, or late Natufian has lunates varying in length from 14.96 mm. at Mugharet el-Wad B1 to 22.86 mm. at Rosh Horesha. Only the final Natufian has lunate lengths clearly separated from the preceding stages. Discounting the north Syrian site of Tell Mureybat Ia, which Valla includes in his analysis as Natufian, the lunate lengths range from 13.07 mm. at Fazael IV to 13.47 mm. at Ain Mallaha Ib. The possiblility that Helwan style retouch is dependent on the absolute length of the lunate is discounted by the fact that it occurs on lunates ranging in size from about 15 mm. to 33 mm. at Mugharet el-Wad. This is approximately the same range seen for the anvil or abrupt style retouch on lunates. The overlap in lunate length from early to late Natufian in Valla's scheme appears to represent a size continuum in the manufacture of this tool type. The decrease in lunate length through time also appears to be independent of raw material size and access.

The Natufian industry of Palestine and the southern deserts can be viewed as a single cultural entity. The assemblages,

Table 5. Radiocarbon dates from late Epipaleolithic sites.

Sites	Dates in B.C.	Source
Mureybat Ia	8,400 ± 150 (Mc-675) 8,220 ± 200 (Mc-635) 8,280 ± 170 (Mc-731) 8,150 ± 170 (Mc-732)	M.-C. Cauvin 1980:17
Rosh Horesha	8,540 ± 430 (SMU-9) 8,930 ± 280 (SMU-10)	Haynes and Haas 1974:379
Nahal Oren	8,096 ± 318 (BM-764)	Burleigh, Hewson and Meeks 1977:152
Jericho	9,140 ± 90 (BM-1470)	Burleigh and Matthews 1982:166
	9,216 ± 107 (P-376)	Kenyon 1981:267-274
Mugharet el-Kebarah	9,200 ± 400 (GL-72)	Bar-Yosef 1981:405
Tell Abu Hureyra	8,842 ± 82 (BM-1121)	Burleigh, Matthews and Ambers 1982b:253
	9,210 ± 110 (BM-1718)	Burleigh, Amber and Matthews 1982a:284
Ain Mallaha III	9,360 ± 880 (Ly-1662)	Evin et al 1979:442
III	9,790 ± 570 (Ly-1661)	Evin et al 1979:443
IVb	9,640 ± 540 (Ly-1660)	Evin et al 1979:443
Mugharet el-Wad B2 cave	9,970 ± 660 (UCLA)	Bar-Yosef and Valla 1979:148
terrace	9,525 ± 600 (UCLA)	Bar-Yosef and Valla 1979:148
Mugharet el-Wad B1	7,845 ± 600 (UCLA)	Bar-Yosef 1981:405
Hayonim Terrace D	9,970 ± 90 (SMU-231)	Henry and Leroi-Gourhan 1976:394
Wadi Judayid	10,140 ± 800 (SMU-805) 10,800 ± 1000 (SMU-806) 10,834 ± 659 (SMU-803)	Henry 1982:437

Table 6. Temporal phases of the Natufian proposed by Valla. -- Three phases of the Natufian (after Valla 1981:97).

	N	% Helwan	Average Length	Micro-Burins
Early Natufian				
Beidha	71	83.09	28.28 mm	+
Erq el-Ahmar A2	162	51.85	27.00 mm	-
Oumm Qala`a	91	72.52	21.74 mm	?
Kebarah B	85	64.70	23.40 mm	-
el-Wad B2	360	47.22	19.46 mm	+ (?)
Hayonim Cave B lower	19	94.73	19.73 mm	-
Ain Mallaha IV (III-II)	64	59.40	22.28 mm	-
Late Natufian				
Rosh Horesha	103-142	0	22.86-19.76 mm	+
Rosh Zin	?	<1	18.00 mm	+
Oumm ez-Zoueitina	21	14.28	20.50 mm	?
Tor Abu Sif	131	6.87	19.00 mm	+
Salibiyah I	66	1.51	20.00 mm	-
Shukbah B	45	0	20.15 mm	-
el-Wad B1	106	10.37	14.96 mm	+
Nahal Oren VI	27	0	15.59 mm	+ (?)
Hayonim Cave B upper	38	36.84	17.81 mm	-
Ain Mallaha Ic	30	46.29	17.50 mm	-
Final Natufian				
Fazael IV	85	0	13.07 mm	+
Nahal Oren V	35	0	13.20 mm	+
Ain Mallaha Ib	69	18.49	13.57 mm	-
Tell Mureybat Ia	?	?	15.00 mm	-

although possessing attributes which vary chronologically, and sometimes geographically, are the product of a highly uniform technological pattern. This pattern is based on the production of short wide bladelets from pyramidal cores (Henry 1973b:162), from which geometric microliths, primarily lunates, are manufactured. The dominance of flakes in the debitage assemblage may possibly be explained as the result of preparation to initially shape the pyramidal cores.

The search for explanations of the variability observed between assemblages has not been very successful when the variables of environment, time and activity have been dealt with singly. Instead, assemblage variability appears to be a product of all three of these variables. Attempts to treat these individually have generally obscured the understanding of the Natufian development.

The C-14 dates from the Natufian (Table 5) suggest the following picture. Helwan retouch, a hallmark of the Natufian culture, was present for most, if not all, of the 10th millennium. The present desert and steppic areas of the southern Levant were the geographical center of the microburin technique, which appeared prior to the Natufian period in these areas. By about the end of the 10th millennium, Helwan style retouch apparently began to decline in popularity, while the microburin technique began to appear in central and northern Palestinian sites, perhaps as early as the mid-10th millennium. In central and northern Palestine, the microburin technique was sporadic in its distribution. This may have been the result of either activity-oriented differences or cultural acceptance, or both.

Sometime during the early 9th millennium, Helwan retouch was replaced by abrupt and anvil type retouch. Throughout this period, lunates decreased in overall length. Within this framework, variation that was related to site type (base versus transitory camp) and to environmental setting, can be nominally distinguished by examining site size, presence of attributes other than the chipped stone assemblages, and site location.

Sites in Lebanon and Southern Syria

It has been suggested by Moore (1978:56) that cultural developments in Lebanon and southern Syria during the time span from 10,500 to 8,300 b.c. represent a regional variant of the Natufian, and therefore are only "Natufian-like" in their attributes when compared with the originally defined Natufian. The sites include Yabrud III (Rust 1950), Jebel Saaidé (Schroeder 1970:199-200), Jiita III and the Beirut Sands (Copeland and Wescombe 1965:92, 129, 134), Taibe (M.-C. Cauvin 1973:105-106), Jiita II (Chavillon and Hours 1970:230), and Amiq II (Hours et al. 1973:466), to mention a few.

The assemblages from these sites are characterized by the domination of lunate microliths. In addition, Helwan retouch is present at Yabrud III and Taibe, along with a few microburins. Both Jiita II and Jebel Saaide' yielded ground stone implements.

There are at least two possible explanations for the appearance of these assemblages in Lebanon and southern Syria. The sites may represent a regional contemporary development of the Natufian keyed to basically the same environmental habitats and resources as the "classic" Natufian, as Moore suggests. Alternatively, this development may be the result of a late intrusion of Natufian elements into a region where a separate evolution of microlithic industries occurred contemporary with the early "classic" Natufian. This is supported by evidence for a detailed local Kebaran and Geometric Kebaran A (Falitian) development, different from the Palestinian area, which has been demonstrated by Hours and Loiselet at Jiita II (1975-1977).

Sites in Northern Syria

In contrast to the development of the Natufian in Palestine and the southern deserts, and to the assemblages found in Lebanon and southern Syria, the assemblages from northern Syria represent a distinct group. At present, this group is represented by collections from only two excavated sites, Tell Abu Hureyra (Moore 1975, 1979), and Tell Mureybat (J. Cauvin 1972, 1974, 1978). It is also known from a test pit at the site of el-Kowm (J. Cauvin et al. 1980), test excavations at Nahr el-Homr (Boerma and Roodenberg 1977; Roodenberg 1976), and surface collections from Dibsi Faraj East (Wilkinson and Moore 1978) and Aarida 7 (J. Cauvin et al. 1980). At Aarida a few Helwan lunates and microburins were found. El-Kowm has Helwan lunates, some direct or inverse retouched lunates, triangles, and microburins. Helwan retouch is not reported at Dibsi Faraj East or Tell Mureybat. A few microburins occur at Tell Mureybat, as do perforators and heavy tools.

An examination of the assemblages from Tell Mureybat (J. Cauvin 1972, 1974, 1978) shows that a special tool type, the erminette (chisel/adze), is present (J. Cauvin 1978:90, Fig. 16, No. 1). This tool type is not reported in Palestine. In addition to this, sickle blades and bone art objects, characteristic of the Natufian, are either nonexistant or rare in the north Syrian assemblages. The Cauvins (J. Cauvin 1978:89; M.-C. Cauvin 1980:14) also mention the presence of polished stone ornaments and heavy peduncular points at Tell Mureybat. These are not found in Palestine.

In essence, much of the rationale for assuming that the northern Syrian sites are Natufian has rested on the fact that these assemblages have lunates, a few of which have Helwan retouch, that round structures are present, and that many of the same chipped stone tool types are present in assemblages from both areas. The premise that these items, taken in isolation from other characteristics of the total site assemblages, environmental settings and economic evidence, is proof that prehistoric industries from different areas represent the same culture, is therefore questionable. This line of argument would lead one to say that Layer B at Zarzi (Garrod 1930; Wahida 1981) or the Gazelle and Seal Mesolithic Layers at Belt Cave (Coon 1951) or Layers 1 through 21 at Ali Tappeh (McBurney 1968) are also Natufian, because lunates and other tools similar to those in the Levant are present in their assemblages.

Other Near Eastern Epipaleolithic Development

The Zarzian, post-Zarzian, Caspian, and Turkish Epipaleolithic, do not closely resemble the Levantine Epipaleolithic industries. However, there are certain broad similarities which merit attention, because they provide a background of additional information regarding cultural development throughout the Near East during this time period. Figure 8 shows the locations of these sites.

The Zagros Foothills

Excavations by D. A. E. Garrod in 1928 at the rockshelter of Zarzi in southern Kurdistan revealed an industry which Garrod originally labeled Upper Paleolithic. She later revised her scheme and called this industry the Zarzian (Garrod 1930:22). Since then, this industry has been found at a number of sites in the Zagros Mountains, including Shanidar Cave Layer B2 (R. S. Solecki 1955), Warwasi Rockshelter (Braidwood, Howe and Reed 1961:2008), Palegawra Cave (Braidwood and Howe 1960:57), Kowri Khan (Braidwood and Howe 1960:55), Pa Sangar (Hole and Flannery 1967:159), Ghar-i Khar (Young and Smith 1966:387), and Turkaka (Braidwood and Howe 1960:55). Garrod believed that two phases of the Zarzian could be distinguished at Zarzi. These were defined by a change from nongeometric to geometric dominated microlithic industries; a change similar to that seen in the Levant. Although Wahida's re-excavation of Zarzi (Wahida 1981) did not show the two phases proposed by Garrod (which may be due to the limited extent of Wahida's excavation), excavations at Palegawra did document this change (Braidwood and Howe 1960:57-59)

There are no C-14 dates from Zarzi, but C-14 dates from Shanidar Cave and Palegawra Cave indicate that the Zarzian existed over a span of several thousands of years. The two C-14 dates from Palegawra are 11,400 + 460 b.c. (UCLA-1714D) and 12,450 $\pm$ 760 b.c. (UCLA-1703A) (Turnbull and Reed 1974:84), while Shanidar Cave Layer B2 has a date of 10,050 $\pm$ 400 b.c. (W-179) (Rubin and Suess 1955:488). R. S. Solecki (1958a and b, 1963) and R. L. Solecki (1980) likened the Shanidar Cave Layer B1 and Zawi Chemi Shanidar manifestations to a post-Zarzian development (Zawi Chemian), somewhat similar to that found at Karim Shanir (Braidwood

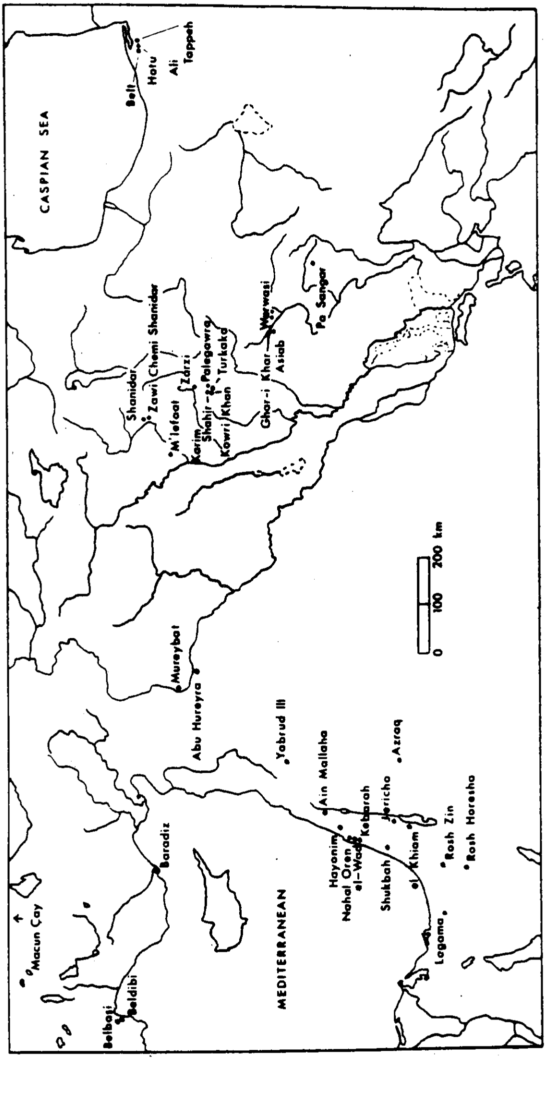


Figure 8. Location of Zarzian, post-Zarzian, Caspian and Turkish sites with respect to the Levant.

and Howe 1960:52-54). The radiocarbon dates indicate that the Zarzian was probably, in large part, earlier than the Levantine Late Epipaleolithic, while the Zawi Chemian (or post-Zarzian) was contemporary with it.

The Zarzian chipped stone industry is characterized by backed blades and bladelets, notches and denticulates, end and round scrapers, burins, microburins, borers and perforators, and pyramidial cores (Garrod 1930:22-23; Wahida 1981:27; Braidwood and Howe 1960:57-58; Young and Smith 1966:387; Hole and Flannery 1967:159). One Helwan lunate has been reported from Shanidar Cave Layer B (R. S. Solecki 1955:412). Geometrics, when present, are usually triangles, and a few trapezes. Lunates are rare.

Storage pits in the Zarzian are known from Shanidar Cave Layer B2 (R. S. Solecki 1963:183). Ground stone is rare, with a few examples being found at Palegawra (Braidwood and Howe 1960:58), Pa Sangar (Hole and Flannery 1967:160), and Ghar-i Khar (Young and Smith 1966:387). The ground stone at Pa Sangar is ochre stained.

The presence of a bone industry in the Zarzian is attested to by the finds from Zarzi (Garrod 1930:22), Palagawra Cave (Braidwood and Howe 1960:58) and Ghar-i Khar (Young and Smith 1966:387). Ornamental objects were located at Pa Sangar and Palegawra Cave.

The flint industry from the post-Zarzian at Zawi Chemi Shanidar, Shanidar Cave Layer B1 and Karim Shahir is not unlike that of the Zarzian, although it generally has fewer microliths (Braidwood and Howe 1960:54). Ground stone in post-Zarzian contexts, on the other hand, is relatively abundant compared to the Zarzian. It occurs in the form of querns, rubbers, pestles, and grooved stones at Zawi Chemi Shanidar (R. S. Solecki 1958a:105; R. L. Solecki 1980:26-35; Solecki and Solecki 1970), at Shanidar Cave Layer B1, where mortars were also found (R. S. Solecki 1963:182), Tell M'lefaat (Braidwood and Howe 1960:51), Karim Shahir (Braidwood and Howe 1960:54), and Tepe Asiab (Braidwood et al. 1961:2008).

Bone tools are also reported from the post-Zarzian at Zawi Chemi Shanidar (R.L.Solecki 1961:125), Tell M'lefaat, and Karim Shahir. Ornamental objects were found at Shanidar Cave Layer B1, Zawi Chemi Shanidar and Karim Shahir. Structures appear during the post-Zarzian at Shanidar Cave Layer B1 (storage pits), where they occur in conjunction with burials, at Zawi Chemi Shanidar as stone circles (R. L. Solecki 1980:53), and at Tell M'lefaat as pithouses (Briadwoo and Howe 1960:51). One interesting manifestation was found at Zawi Chemi Shanidr in the vicinity of the stone circle structure. This was the association of fifteen goat skulls with vulture, sea eagle and bustard wings. R. L. Solecki (1977) has interpreted this as evidence of a bird ritual.

Leroi-Gorurhan (in Wahida 1981:33-46) studied pollen from Zarzi, which appears to have been steppic at the time of occupation. If the Zarzian existed prior to 10,000 b.c., this analysis is comparable to the steppic conditions revealed by the Lake Zeribar pollen core (van Zeist and Botematema 19771). At Palegawra, the Zaribar pollen core (van Zeist and Bottema 1977:81). At Palegawra, the Zarzian occupation is also characterized by a dry sagebrush steppe for most of its duration (Turnbull and Reed 1974:88). By about 12,150 to 10,150 b.c., oak and Pastacia began to appear. The charcoal from Palegawra included oak, tamarisk, poplar, and conifer (Turnbull and Reed 1974:88). Following 10,000 b.c., trees probably began to invade the area, with increased humidity and higher temperatures. This would coincide roughly with the Zarzian to post-Zarzian transition, postulated for Luriastan at about 9,000 b.c. by Hole and Flannery (1967:166). Little evidence exists to date on plant foods utilized by Zarzian and post-Zarzian prehistoric groups. Leroi-Gourhan (1969:144) has said that cereal grass pollen from Shanidar Cave during the Mousterian, Baradostian, and Zarzian was small in size. This suggests that cereals were not being cultivated.

Faunal evidence from the Zarzian is abundant. Zarzian sites have produced evidence for the exploitation of fox, gazelle, goat, tortoise, and land snails, especially Helix salamonica, at Zarzi (Bate 1930:23; Harris 1961:110), red deer, onager, sheep, goat, gazelle, pig and fox, as well as some cattle, numerous birds, and landsnails at Palagawra (Turnbull and Reed 1974:132-133), and landsnails and goats at Shanidar Cave Layer B2 (Perkins 1960:77). Post-Zarzian fauna is represented by goat, sheep, red deer, pig, fallow deer, roe deer, fox, bear, beaver, marten, tortoise, and landsnails at Shanidar Cave B1 and Zawi Chemi Shanidar (Perkins 1964:1565), and sheep/goat, gazelle, pig, cattle, deer, wolf marten, fox, birds, and tortoise at Karim Shahir (Braidwood and Howe 1960:53-54).

The Zagros Epipaleolithic to early proto-Neolithic developments are separate from developments occurring in the Levant. The Epipaleolithic transition from triangles and trapezes to lunates is not seen in the Zagros, and with the exception of the one Helwan lunate reported from Shanidar Cave Layer B (probably a fortuitous occurrence), Helwan retouch does not occur. A heavy tool component is also not reported in the Zarzian.

However, there are a few broad similarities with the Levant, some of which probably result from a similar hunting and gathering existence with a seasonal round (Mortensen 1972). A wide variety of animals occur, along with birds and land snails, as was the case at some sites of the late Epipaleolithic in the Levant. Direct evidence of plant foods is lacking, but the increasing abundance of ground stone implements (both querns and rubbers, and mortars and pestles), suggests an increasing emphasis on plant food processing during the post-Zarzian. The change from nongeometric to geometric microlithic assemblages in the Zarzian is the same sort of trend seen in the development from the Kebaran to the Geometric Kebaran A in the Levant.

In broad terms, the developments in the Natufian and in northern Syria appear to be more closly similar to the post-Zarzian (proto-Neolithic) than they are to the Zarian. The post-Zarzian sites date to the last phases of the late Epipaleolithic in the Levantine region. This would suggest that early plant cultivation or intensity of plant use in the post-Zarzian developed slightly later than similar developments in the Levant. This may relate to the fact that many of these sites are not in prime agricultural localities.

The Caspian Littoral

There are three reported sites from the Caspian littoral. These are Hotu Cave, Belt Cave, and Ali Tappeh (Fig. 8). The industries have been likened to the Zarzian. A series of radiocarbon dates (Table 7) show that they overlap with the Zarzian and post-Zarzian. The Caspian industries apparently span a range of time from about 10,500 to 8,800 b.c. Thus, they are contemporary with the late Epipaleolithic of the Levant.

Belt Cave (Coon 1951:69) is characterized by a blade industry. There are several types of scrapers (end, notched, sheep, disc), saws, drills, a few sickle blades, and a few geometric microliths, mainly triangles and trapezes. Geometric microliths apparently increase in number through time. On the other hand, the Hotu Cave industry has few blades and blade tools (Dupree 1952:250). There are no microliths, but there are scrapers of various types, drills, awls, and perforators, and a few sickle blades. The industry from Ali Tappeh is characterized by a rarity of backed elements, but a dominance of notched blades. There are also notched flakes, endscrapers, and geometric microliths (scalene triangles) (McBurney 1968:400-405). McBurney has suggested that Coon's excavation techniques and his use of a 1/2" mesh screen for sieving resulted in the loss of most of the microlithic industry from Belt Cave and Hotu Cave. This does not explain, however, why belt Cave has a blade industry, and Hotu Cave a flake industry, especially since the late Epipaleolithic C-14 dates which are consistent from both these sites (Table 7) are approximately contemporary. In addition, these sites are located close to one another, and yet seemingly developed two different manufacturing technologies. This does not appear to be a likely occurrence.

Other items in the Caspian Epipaleolithic assemblages include bone tools, awls, and a shaft straightener from Belt Cave (Coon 1951:74-75), perforators, needles, chisels, spatulae, and lissoirs, in the upper gravels at Hotu Cave (Dupree 1952:253), and needles, hooks and a spatula at Ali Tappeh (McBurney 1968:405). Ground stone in the form of querns and rubbers is known from Ali Tappeh and ground stone is present at Belt Cave. Ornaments include shell artifacts at Belt Cave, and a bored tooth pendant from Ali Tappeh. No structures are recorded, but burials are known from Hotu and Belt Caves.

There is no direct evidence of plant food use, although the presence of ground stone may suggest that some plant foods were processed. Faunal evidence is abundant. Both Coon (1952:245) and McBurney (1968:396-397) note that fluctuations in the level of the Caspian Sea level led to different emphases on faunal resources. Thus, when the Caspian Sea was closer to Hotu Cave, more seals were exploited at the cave (Coon 1952:245). However, this sequence of faunal change may have been due to alternations of warm and colder phases, rather than to fluctuations in the level of the Caspian Sea.

The upper late Epipaleolithic at Belt Cave was characterized by gazelle, cattle, sheep and goat, swan, goose, bustard, and grouse, while the lower levels had seal, red deer, and Caspian rudd (Coon 1951:44-49; 1957:172-173). Seal, voles, cattle, pig, sheep, gazelle, and thrush were present at Hotu Cave, with seal predominating in the lower levels, and vole in the upper levels (Coon 1957:172-173). The presence of vole may be indicative of the habits of predatory birds bringing their prey back to their nests in the cave. The faunal assemblage at Ali Tappeh shows fluctuations through time in the percentages of gazelle, sheep/goat, and seal (McBurney 1968:396-397).

The Caspian chipped stone industry shows little relationship to that from either the Natufian area or the north Syrian Epipaleolithic. It is similar to, but appears to be distinct from the Zarzian. It is difficult to say how much of this difference is the result of Coon's methods of excavation. McBruney (1968:388-390) has suggested that since Coon dug in horizontal levels, the C-14 date from the Gazelle Mesolithic at Belt Cave may be from a Neolithic context. At Hotu Cave, a figurine fragment, which Dupree (1952:253) interpreted as a Venus figurine, might actually belong to later Neolithic figurine manufacture. This indicates that serious problems exist with the interpretation of the artifactual assemblages from both Belt and Hotu Caves. The "random" aspect of the C-14 dates from McBurney's excavation at Ali Tappeh (Table 7) also indicates that problems in either excavation, or in the quality of the samples used for radiocarbon dating, existed at Ali Tappeh.

Ground stone is not abundant at the Caspian sites. The faunal assemblages reflect changes in temperature and moisture through time, and indicate that these late Epipaleolithic hunters and gatherers were as wide-ranging in their exploitation of fauna as were their contemporaries in the Natufian, north Syrian, and Zarzian areas. The Caspian Epipaleolithic, in what was probably an interface between the wooded hills and mountains, and the sea coast, has not

Table 7. Radiocarbon dates from the Caspian Epipaleolithic.

Site	Age in B.C.	Source
Belt Cave		
Gazelle Mesolithic	8,785 ± 575 (P-24)	Ralph 1955:150
	8,360 ± 510 (P-24a)	
Seal Mesolithic	11,400 ± 800 (P-20)	
	11,550 ± 750 (P-20b)	
Hotu Cave		
hearths	9,190 ± 590 (P-12)	Ralph 1955:151
vole eaters	9,220 ± 570 (P-38)	
black level under Red Gravel II	11,860 ± 840 (P-39)	
under Red Gravel II	8,781 ± 269 (P-1623)	Lawn 1971:372
Ali Tappeh		
layers 20-21	8,830 ± 320 (Gx-0699)	McBurney 1968: 395-396
layers 18-19	9,290 ± 360 (Gx-0700)	
layer 17	9,430 ± 410 (Gx-0689)	
layers 14-16	10,560 ± 380 (Gx-0697)	
layers 13-14	9,510 ± 370 (Gx-0696)	
layers 11-13	9,380 ± 410 (Gx-1095)	
layer 12	9,690 ± 410 (Gx-0694)	
layer 12	8,365 ± 410 (Gx-0693)	
layer 6	10,480 ± 600 (Gx-0692)	
layers 5-6	8,570 ± 410 (Gx-0691)	
layers 1-3	10,460 ± 480 (Gx-0690)	

yielded evidence of cultivation. It is possible that the situation here was generally similar to that of the Natufian. It is interesting to note that the Caspian Epipaleolithic has yielded a few sickle blades, which are found in larger numbers in the Natufian in a Mediterranean forested environment.

The Turkish Evidence

Two Epipaleolithic sites are known on the Mediterranean coast of Turkey, Beldibi and Belbaşi (Fig. 8). The chipped stone industry from Beldibi was divided into two phases during the late Epipaleolithic (Bostanci 1959:147-150). The upper phase, from Level C1, has burins, microburins, sickle blades, backed blades, endscrapers, borers, notched blades, one pick, and three Helwan retouched blades. However, an illustration of a Helwan blade (Bostanci 1959:169, Plate VI, no. 10-10a) clearly shows that the author has misdefined Helwan retouch as alternate retouch, which occurs on the exterior along one lateral edge and the interior of the opposing lateral edge. Therefore, the presence of Helwan retouch at Beldibi is questionable. The Level C2 assemblage is reported to have larger scrapers than in C1, borers, microburins at the top of the level, sickle blades, lunates, triangles, and Helwan blades and one Helwan lunate. Again, the illustration (Bostanci 1959:170, Plate VII, no 5) shows that the retouch defined by the author as Helwan, is not Helwan. Other items reported from Beldibi are pierced sea and land shells, fragments of a human skull, painted pebbles, and a bone point. Animal bone was also found, but aside from a deer antler, no species identification is given.

At the site of Belbaşi, the second level is said to be late Upper Paleolithic or Epipaleolithic. The chipped stone industry is composed of numerous scrapers, points, micoburins, burins, backed blades, some lunates, and one "Helwan" point (Bostanci 1962:265). The "Helwan" point (Bostanci 1962:282, Plate IV, no.1) does not have Helwan retouch, but is retouched along both exterior lateral edges (distally) to form a point. Some human bone was found, as well as faunal remains of mountain goat and deer. The lunates present in the assemblage have a very long and narrow appearance, In fact, the overall character of the microliths presented on Plate V (Bostanci 1962:283) suggests that this industry is a form of the Geometric Kebaran A, as has also been noted by Bar Yosef (1970a:193).

Epipaleolithic sites are extremely rare in Turkey. Two open air sites are known (Fig. 8), in addition to the rockshelters at Beldibi and Belbaşi. These are Baradiz and Macun Çay (Ensin and Benedict 1963:344). Both have microliths. At Macun Çay there are lunates, triangles, trapezes, and microburins.

There is very little faunal data and no plant data available for these Turkish sites. The presence of deer and mountain goat indicates that the area was probably wooded, more than likely with a Mediterranean forest cover. It is interesting that sickle blades appear at Beldibi, as they do in the coastal, Mediterranean forest interface in the Natufian area. The chipped stone assemblage, for the most part, is similar to that from many of the sites in the Levant during the late Epipaleolithic. The reported presence of Helwan retouch appears to be an error. Thus, this apparent link between Turkey and the Levant probably does not exist. The industry from Belbaşi is probably related to the Geometric Kebaran A, rather than to the Natufian or north Syrian late Epipaleolithic.

Summary

The traditional view of the late Epipaleolithic evidence in the Levant as representative of a single "Natufian" culture is most seriously challenged by the finds from the northern Syrian sites of Tell Abu Hureyra and Tell Mureybat. While the prehistoric cultural groups that occupied the Levant during this period shared several broad features in their chipped stone asemblages, subsistence strategies, and perhaps their social organization, it does not seem defensible to lump these groups under the single cultural entity of Natufian. Instead, these cultural developments are more appropriately grouped under the general term of late Epipaleolithic.

From all evidence, hunting strategies followed the pattern set earlier during the Kebaren and Geometric Kebaran A. That is, prehistoric groups during the late Epipaleolithic "specialized" by concentrating on those large ungulate species most frequent in the vicinity of the site. Thus, the site of Beidha had high proportions of goat, while Mugharet el-Wad and Nahal Oren had high percentages of gazelle, and Tell Abu Hureyra and Tell Mureybat showed a preference for onager and gazelle. A variety of smaller animal species, such as fox and hare, and other larger animals, like wild pig, auroch, roe deer, red deer, and fallow deer, were also exploited. Some scholars, particularly Legge and Saxon, have suggested that the high proportions of young gazelle taken by prehistoric groups indicate that gazelle herding or hubandry was present. While this may be a plausible idea, it is not possible at present to separate what may have been gazelle herding from hunting patterns that favored the killing of young animals in the wild herds.

On the other hand, the collection of plant foods appears to have undergone a change from simple collecting to intensive collecting and even an emphasis on plant cultivation, at least in some areas. Site catchment analyses have shown that most Palestinian late Epipaleolithic sites are located in areas with low amounts of potentially arable land. In contrast, the northern Syrian sites are found close to abundant potentially arable land. Macrobotanical remains recovered from the site of Tell Abu Hureyra have indicated that large quantities of wild einkorn were utilized. This, in conjunction with the presence of weeds indicative of cultivated fields, and the semi-permanent, if not permanent, nature of the site suggests that the steppic area of northern Syria may have been one area practicing early cultivation.

In contrast, the lack of arable land surrounding most Palestinian sites, the ground stone tool kit, which emphasizes mortars and pestles, rather than the querns and rubbers usually associated with cereal processing, and the Mediterranean forest cover prevalent throughout much of Palestine, suggests that the Palestinian groups were concentrating on plant food resources other than cereals. This difference in emphasis on plant food species, on methods of obtaining plant foods, and in the macro-environmental setting between northern Syria and the Palestinian area, suggests that these regions supported different cultural traditions. A detailed examination of chipped stone assemblages from the two areas further confirms that differentiation between northern Syria and Palestine.

The Palestinian development, to which the term Natufian should be restricted, is characterized in its early phases by Helwan style retouch, usually on lunates, but also on sickle blades. Lunates tend to be relatively long averaging up to 28 mm. The microburin technique was well developed, but was confined to the present desert areas of the southern Levant during the early part of the Natufian. Later, the microburin technique spread into central and northern Palestine, but was only spaoradically distributed there. The Helwan style retouch was gradually replaced by abrupt and anvil retouch. Lunates diminished in length through time, with the latest assemblages averaging about 13 mm. Technologically, the Natufian industry was characterized by the production of short, wide bladelets from pyramidal cores. In addition to chipped stone, the Natufian was also characterized by a rich varied bone industry, including bipoints, barbed points, carved hooks, sickle hafts (sometime decorated), and pendants.

In contrast, the northern Syrian sites show few of the distinctive industrial elements or developmental progressions that characterize the Natufian. Helwan retouch does not appear at Tell Mureybat, a late site, although a few examples have been recovered in surface collections and in test pits in the el-Kowm area and at Nahr el-Homr. The microburin technique is known from Tell Mureybat. Bone artifacts are present at both Tell Mureybat and Tell Abu Hureyra, but have a restricted range of types and include no art objects. The only trend apparently showing the same temporal change as in the Natufian is the length of lunates, which averages 15 mm. at Tell Mureybat. The northern Syriana sites have a small but significant heavy tool component and there is a special form of chisel found at Tell Mureybat.

The importance of maintaining a distinction between the Natufian and northern Syrian areas is highlighted by evidence from other areas of the Near East, including the Zagros foothills, Caspian and Turkish areas. These latter regions share many similarities with the Levant during the Epipaleolithic. These consist of chipped stone assemblages with microlithic components, a hunting pattern that concentrates on large animals common to particular site vicinities, an increase of ground stone implements through time, and an apparent correlation between forested environments and the presence of sickle blades. However, as discussed previously, there are many specific differences in the assemblages that probably relate to cultural and technological differences, both within and between regions. The areas lying outside the Levant during the Epipaleolithic demonstrate that although general similarities existed in assemblages and subsistence strategies of diverse areas, these merely reflect that the fact that prehistoric groups could adapt similarily without having had extensive cultural contact.

Thus, a recognition of the distinct nature of the late Epipaleolithic assemblages in the northern and southern Levant will aid the understanding of the differences between these two areas. This will ultimately contribute to the interpretation of adaptations to different environments and the different chronological developments within the two regions. Since the late Epipaleolithic includes some of the earliest evidence for cultivation, it is of exceptional interest in treating the question of how and why early cultivation arose. This treatment can only be accomplished through the recognition of the significance of the distinct cultural manifestations in the several geographical regions of the Levant.

CHAPTER 4

TELL ABU HUREYRA AND THE NORTH SYRIAN LATE EPIPALEOLITHIC

The site of Tell Abu Hureya, south of the Euphrates River and overlooking its floodplain, is about 130 km. east of Aleppo and 35 km. downstream from Meskene (Moore 1975b:52) (Fig. 9). Tell Abu Hureyra is a prehistoric mound that is located on the first major terrace of the Euphrates Valley. Thus, it commands a good view of both the east and west along the valley (Moore 1975b:52). The east and south sides of the mound slope gently, while the north and west sides are steep slopes from the floodplain up to a north-south ridge that is the main axis of the mound. The dimensions of the mound are 480 m. north-south, and 290 m. east-west (Moore 1975b:52). Two erosional gullies are present on the west slope. Modern disturbance consists of a cemetery and a few mud-brick buildings.

At the time of excavations, 1972-1973, the main channel of the Euphrates River flowed about one kilometer north of Tell Abu Hureyra. A secondary channel of the river was located at the foot of the western slope. This was dry at the time of excavation (Moore 1975b:52). It is suggested by Moore (1975b:53), that during the prehistoric occupation of Tell Abu Hureyra, the Euphrates River flowed closer to the site. This observation is based on the fact that the river has frequently changed course, and water had been flowing in the secondary channel as late as 1943. The construction of the dam at Tabqa has resulted in the flooding of the area in which Tell Abu Hureyra, and Tell Mureybat, are located.

Tell Abu Hureyra is situated at the junction of two different resource areas, the Euphrates floodplain and the open steppe (Moore 1979:67). This is a favorable location, which was even more favorable prehistorically, since climatic conditions during the late Epipaleolithic were more propitious. The record of climatic and environmental change in this region during prehistory has been documented by several pollen core studies. The pollen core from the Ghab Valley in western Syria is the closest one to Tell Abu Hureyra. Here, the sequence shows a change from steppic conditions in Zone Y5, which end about 10,300 b.c., to a transitiion from steppe to forest in Zone Z1 (Niklewski and van Zeist 1970:750, 753, Table 2). Zone Z1 ends about 10,000 b.c. During Zones Z2-3, the western side of Ghab, the Jebel Alaouite, was forested, while the eastern side, the Jebel Zawiyé, was a steppe forest. The invasion of oaks and other trees around 10,000 b.c. documents an increase in humidity in this area.

The same general pattern is seen in the pollen cores from Lake Zeribar in the Zagros Mountains of western Iran, where

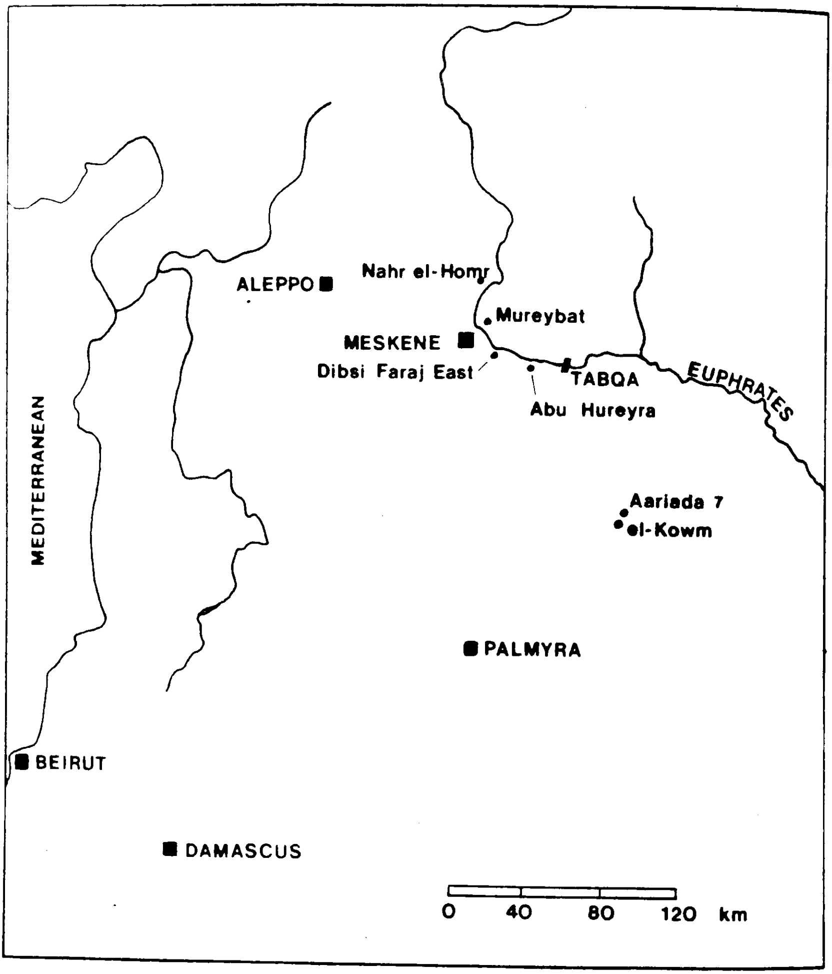


Figure 9. The location of north Syrian late Epipaleolithic sites. -- After Moore 1975a:122, Figure 1.

steppic and dry conditions prevailed prior to 12,000 b.c. Slightly later than in the Levant, oaks and other trees began to become established in the Zagros area (van Zeist and Bottema 1977:81; Bottema and van Zeist 1981:118). This indicates an increase in humidity for the Zagros area.

The recent work at Lake Huleh by Tsukada, also shows the pattern from dry steppic conditions to forestation, which occurred here slightly earlier than in the Ghab region (Bottema and van Zeist 1981:116). This evidence, as stated earlier, has led Moore (1979:69) to suggest that the major environmental zones in the Levant, Mediterranean forest, open forest, and steppe, were much broader during the late Epipaleolithic (Fig. 10).

Excavation Methods and Results

Seven trenches (A-G) were excavated at Tell Abu Hureyra (Fig. 11). The late Epipaleolithic component, found in Trench E, was located under three meters of Neolithic deposits (Moore 1975b:56). The late Epipaleolithic exposure consisted of forty-nine square meters, with a depth of greater than one meter. The excavation was modeled after the strategy of Harris (1975), which allowed a diagramatic synthesis of the relationships (earlier than, later than, or contemporary with) between levels designated during excavation. This resulted in seventy-eight levels (252-330) corresponding to the late Epipaleolithic occupation (Fig. 12) (Moore, personal communication 1983).

All excavated soil was dry sieved using industrial perforated screens of one cm. and 0.3 cm. in diameter. This facilitated recovery of microliths from Levels 252-330 (Moore 1975b:54). In addition to dry sieving, a sampling procedure was used to select soil for froth flotation. Screens of one mm. and three mm. mesh were used in this procedure. As a result, most macrobotanical remains were recovered, as well as some artifacts, rodent and fish bones, insects, and small mollusca (Moore 1975b:55).

The artifactual remains consisted of chipped stone, ground stone, bone tools, stone bowls or cups, and beads of stone, bone and shell. These were recovered from a fill of dark occupational debris, which was leached grey near the top of the late Epipaleolithic deposit (Moore 1975b:56). The characteristics of the chipped stone assemblage indicated that a full range of flint knapping activities occurred at Tell Abu Hureyra (Chapter 5). This included core reduction, tool manufacture, and tool resharpening/maintenance. The major microlithic tool type was the lunate. Also present in the assemblage were numerous scrapers, burins, and notches. Borers, perforators, and various backed elements occurred in smaller quantities. Heavy tools, predominently gouges, axes, and blunted implements, formed a small but significant proportion of the chipped stone component.

The ground stone component was composed of eleven quern

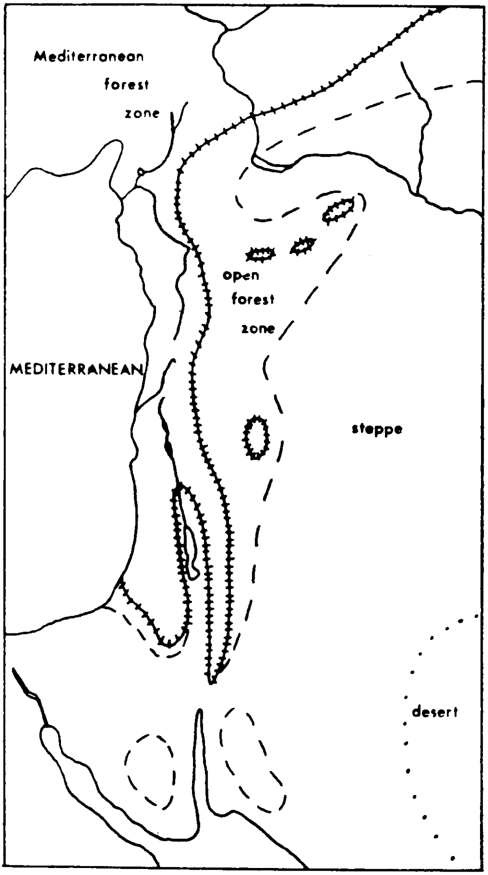


Figure 10. Hypothesized reconstructed vegetation zones ca. 9,000 b.c. -- After Moore 1979b:69.

++++++++++++ limit of Mediterranean forest zone
----------- limit of open forest zone
.... limit of desert zone

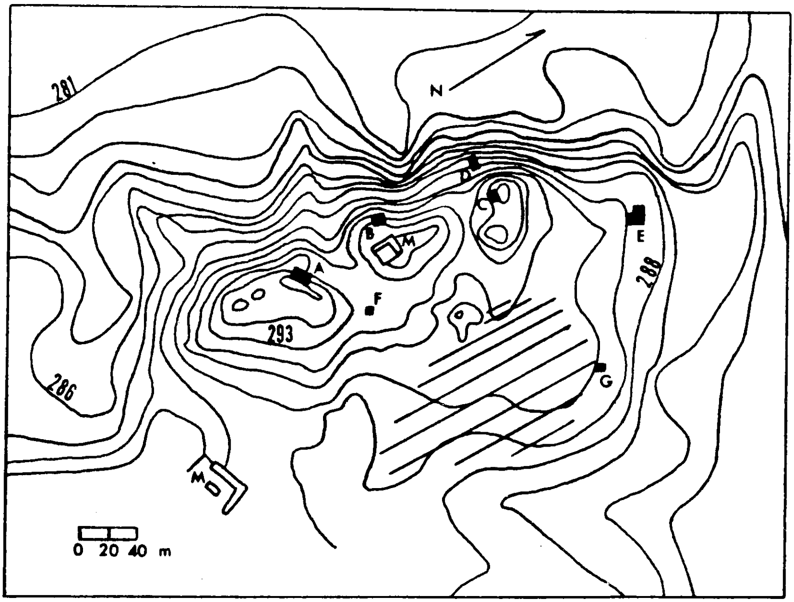


Figure 11. Location of excavated trenches at Tell Abu Hureyra. -- After Moore 1975b:54, Figure 4. M = modern mud-brick buildings; A-G = trenches; /// = modern cemetery. Contours in one meter intervals.

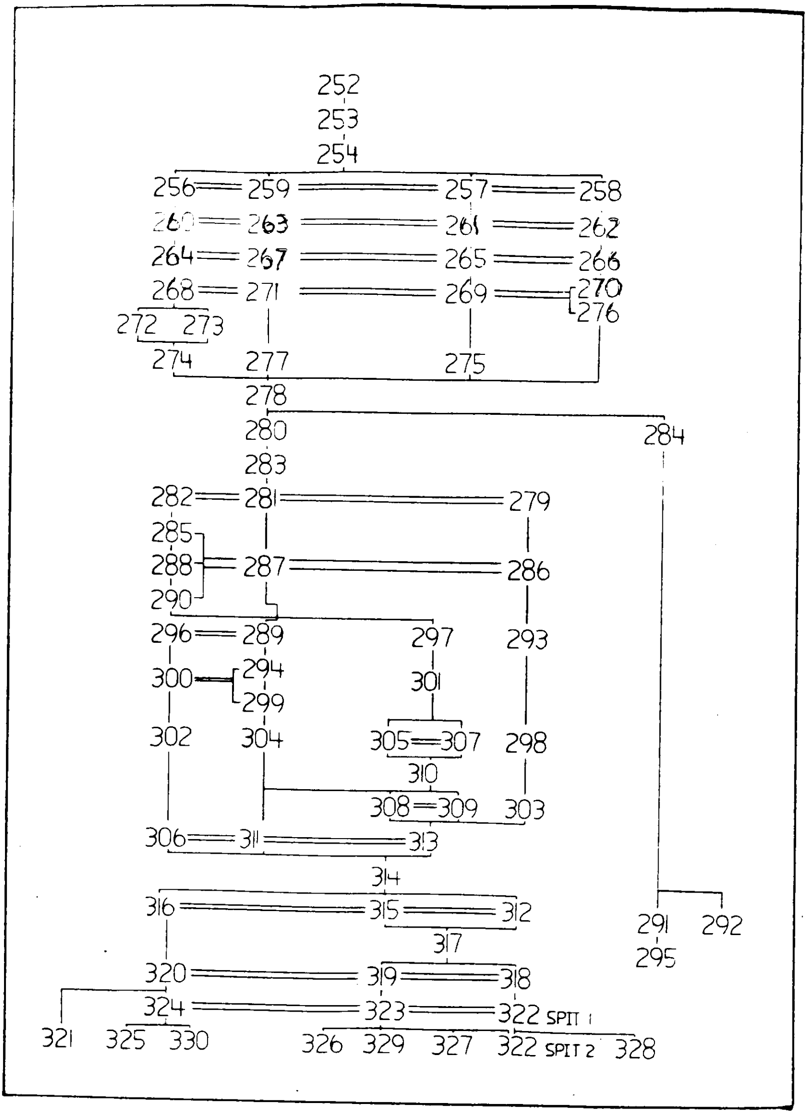


Figure 12. Level hierarchy at Tell Abu Hureyra, Trench E.
-- A. Moore, personal comunication 1983
====== = contemporary

fragments, one mortar fragment, two pestles, and several notched pebbles, perhaps used as weights for nets for fishing in the Euphrates (Moore 1975b:58). Fragments of rough stone bowls or cups were also recovered.

There were thirty-five bone tool specimens. These consisted of awls, projectile points, needles, double-ended points (bipoints), and a spatula (Moore 1975b:58). Ornamental objects included beads of bone, stone, and shell, as well as pendants (Moore 1975b:58).

Several pits, probably hut structures, surrounded by postholes, and hearths, plus a cut bank shelf (Fig. 13) were found at the bottom of the late Epipaleolithic deposits. These shallow pits, up to 2.5 m. in diameter and 0.7 m. deep, had been excavated into the natural subsoil (Moore 1975b:56). A number of associated hearth areas occurred on the shelf area. On the basis of ground stone items and other artifacts found in these pits, Moore (1975b:56) has suggested that these pits were working or dwelling hollows, and were probably partly roofed over.

The Late Epipaleolithic Occupation at Tell Abu Hureyra

The environmental conditions prevailing during the late Epipaleolithic period, and the location of Tell Abu Hureyra at the boundary between the steppe and the riverine resource areas, produced a situation with an abundance of diverse food resources. These are reflected in the economic evidence from the site. Preliminary faunal analysis by Legge (in Moore 1975b:74-76; Moore 1982:227) has indicated frequent hunting of steppic animals. Animals represented include gazelle (65.3%), and equid, probably the onager (15.2%), sheep/goat (10.8%), and hare (8.7%). Fish and wildfowl from the valley were also exploited.

Abundant plant remains were also recovered (Hillman in Moore 1975b:70-73; Moore 1982:228-229). The steppic area was characterized by steppe grasses (*Stipa*). Trees, which yield fruits and/or nuts, such as the hackberry and the turpentine, were probably located either in the immediate vicinity, or within a fews days' walking distance (Hillman in Moore 1975b:70). The most abundant cereal grass was the wild-type einkorn. A few specimens of wild-type barley and rye were also found. Other plant foods included lentils, vetches, and caper. Hillman suggests that seeds of grasses (*Stipa* and *Polygonum*) might have been collected as foods. *Polygonum*, *Atriplex* (saltbush), *Chenopodium*, *Setaria* (foxtail grass), and *Echinochloa* (grasses), are representative of valley bottom vegetation (Hillman in Moore 1975b:73). Modern land use of the area around Tell Abu Hureyra (Moore 1975b:55, Fig. 10) shows that a large quantity of arable land is available. Moore has suggested that the abundant einkorn, and the favorable situation of Tell Abu Hureyra with respect to arable land, favors the

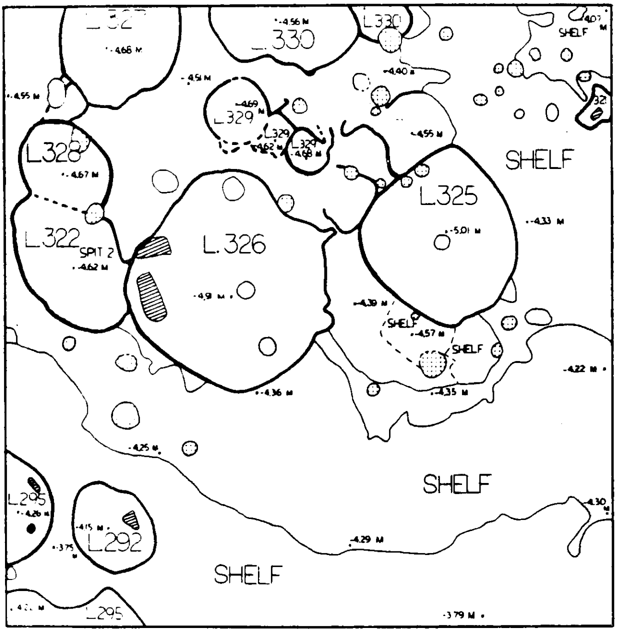


Figure 13. Basal plan of late Epipaleolithic occupation at Tell Abu Hureyra.

Heavy lines = pit outlines
Light lines = cut shelf outlines
Open circles= possible postholes
Stippled circles = postholes
Diagonal lines = groundstone
x = elevation spots (below datum)

possibility that einkorn was being cultivated (Moore 1982:228). This is supported by the presence of weeds that are characteristic of cultivated fields. Recent work by Hillman (1978) has shown that harvesting techniques, as well as a variety of other factors, can influence the change or lack of change in morphological characteristics of cultivated plants. All of this evidence suggests that it is likely that the wild-type einkorn from Tell Abu Hureyra during the late Epipaleolithic was cultivated to some extent.

Several lines of evidence other than abundant food resources support the intensity of occupation at Tell Abu Hureyra. Moore (1982:228) has suggested that the plant remains indicated that Tell Abu Hureyra was occupied from the spring until the late autumn. It is possible that winter occupation also occurred, but no direct evidence exists for this. The pit structures suggest that considerable effort was devoted to construction. Such effort is not characteristic of sites other than base camps. In addition, artifactual remains indicate that, as mentioned before, the full range of chipped stone production occurred. Ground stone is also characteristic of base camps where a full range of activities occurred, including plant food processing and ochre grinding. Thus, the inhabitants of Tell Abu Hureyra were probably semi-sedentary, if not sedentary.

The depth of deposits assigned to the late Epipaleolithic suggests that Tell Abu Hureyra was occupied and reoccupied over the span of several centuries. This is confirmed by C-14 dates of 9,210 ± 110 b.c. (BM-1718) and 8,842 ± 82 b.c. (BM-1121) (Burleigh, Matthews and Ambers 1982:253; Burleigh, Ambers and Matthews 1982:284), as well as recently obtained C-14 dates that span the 9,100 to 8,300 b.c. range (Moore 1985 personal communication).

The Place of Tell Abu Hureyra in Relation to Other Late Epipaleolithic Sites in Northern Syria

The steppic-riverine environment of Tell Abu Hureyra is common to three other reported late Epipaleolithic sites in northern Syria. Dibsi Faraj East, Tell Mureybat, and Nahr el-Homr are also located on the interface of the steppe and the Euphrates River Valley (Fig. 9). Dibsi Faraj East is on the south side of the Euphrates River, 18 km. southeast of Meskene and 16 km. northwest of Tell Abu Hureyra (Wilkinson and Moore 1978:26). It was surface collected in 1973. The only cultural materials recovered which date to the late Epipaleolithic are chipped stone artifacts. The chipped stone assemblage closely resembles that from Tell Abu Hureyra. The lack of Helwan retouch and the long length of the lunates suggest that the late Epipaleolithic occupation at Dibsi Faraj East may be contemporary with that of Tell Abu Hureyra. A variety of tools and debitage was found, indicating that this site was a focus of flint knapping activities. Since Dibsi Faraj East shares the same environmental setting as Tell Abu Hureyra, presumably some of the same hunting and gathering activities also occurred here. Moore (Wilkinson and Moore 1978:36) suggests that Dibsi Faraj East was a habitation site, based on the remains of dark ashy soil, and the wide scatter of artifacts dating to the late Epipaleolithic period. However, this cannot be confirmed without information from excavation.

Nahr el-Homr is also located on the same side of the Euphrates River as Tell Abu Hureyra and Dibsi Faraj East, although it is north of Meskene. Four test pits were excavated in the talus slope areas where the highest concentration of surface artifacts was located (Boerman and Roodenberg 1977:10). Test pit C yielded four stratigraphic levels (Boerma and Roodenberg 1977:11). Of these, Level II produced some late Epipaleolithic tool types, including a few lunates with Helwan style retouch. Interestingly, the <u>hachette</u> (hachet) recovered from this level is very similar in appearance to the axe at Tell Abu Hureyra (Boerma and Roodenberg 1977:12, Fig. 3:9). There are also several arrowhead types, including peduncular points (Boerma and Roodenberg 1977:11). Peduncular points, as discussed earlier, are one of the elements found at Tell Mureybat in conjunction with the late Epipaleolithic deposits, and used by the Cauvins as a marker for the Euphrates "late Natufian."

The associations of the chipped stone elements found in the Level II assemblage suggest at least three possible explantations. The Level II assemblage may be a mixture of several time horizons, including the early and late Epipaleolithic and the aceramic Neolithic. This is suggested by the presence of two Neolithic-type arrowheads (Boerma and Roodenberg 1977:13, Fig. 4:6-7) along with the Helwan lunates.

On the other hand, the Helwan style lunates may be a fortuitous occurrence within an early Epipaleolithic assemblage that is intermixed with the aceramic Neolithic artifacts. This may be supported by the fact that only eleven geometric microliths were found in a microlithic assemblage numbering seventy-two. Among the geometric microliths, there were three small Helwan lunates, in addition to one large Helwan lunate (not classified as a microlith).

Finally, if one assumes that the association of the Level II chipped stone elements is undisturbed, then a curious anomaly emerges. The late Epipaleolithic assemblage at Nahr el-Homr would, in this event, possess the following characteristics. Peduncular points, dating to the very late Epipaleolithic at Tell Mureybat, around 8,300 b.c., would be associated with a predominantly nongeometric microlithic component, which in dated contexts appears only in the 10th millennium at sites in the southern Levant. Both of these tool groups would, in turn, be associated with Helwan style retouch, known from dated contexts only from the 10th millennium. Thus, the most probable explanation for the Nahr el-Homr assemblage from Level II is that it represents a mixture of several time periods.

Tell Mureybat is located upstream from Dibsi Faraj East and Tell Abu Hureyra, and downstream from Nahr el-Homr, on the opposite side of the Euphrates River. Phase Ia represents the final manifestation of the late Epipaleolithic in northern Syria, with C-14 dates averaging around 8,250 b.c. (M.-C. Cauvin 1980:17). This occupation is thus contemporary with the latest occupation at Tell Abu Hureyra (Levels 252 -279; not discussed at this time), but close to a millennium later than Levels 280-330 (discussed here) from the late Epipaleolithic at Tell Abu Hureyra. At Tell Mureybat, in addition to a well developed flint industry that shares many features with that found at Tell Abu Hureyra, there are numerous bone tools. These consist of serrated objects, bipoints, awls, lissoirs, and a pierced phalange (Stordeur 1977). Several pits are present. Food resources include onager, gazelle, cattle, fish, birds, shellfish, and wild-type einkorn (J. Cauvin 1972:108, 1978:73).

The evidence from Tell Mureybat indicates that the late Epipaleolithic occupation here was not unlike that at Tell Abu Hureyra. The similar environmental setting, cultural artifacts, and the same types of food resources, indicates that the economy at Tell Mureybat was probably similar to Tell Abu Hureyra, although J. Cauvin (1978:21) believes that the inhabitants of Tell Mureybat were collecting wild einkorn rather than cultivating and harvesting it.

The other northern Syrian area investigated to date is that of el-Kowm, an oasis 100 km. north-northeast of Palmyra (Fig. 9). The el-Kowm area is in a steppic region, surrounded by slightly higher areas to the northeast and southwest. Two sites dating to the late Epipaleolithic were located. These are Aarida 7 and el-Kowm I (M.-C. Cauvin 1981a:380, 384). Only chipped stone assemblages are available, and these are few in number. The lunates are long, as at Tell Abu Hureyra, and some have Helwan retouch. The somewhat different environmental setting, and the presence of Helwan retouch, may indicate that this area was not closely allied to developments along the Euphrates. Alternatively, based on the presence of Helwan retouch, it is possible that the el-Kowm late Epipaleolithic is earlier than the Tell Abu Hureyra late Epipaleolithic, as M.-C. Cauvin (1981a:387) suggests.

Summary

The full range of cultural artifacts, fauna, and plant remains from Tell Abu Hureyra indicates that inhabitants at this site during the late Epipaleolithic practiced intensive collection or cultivation of wild-type einkorn, as well as hunting of both the gazelle and the onager. The environmental situations of a steppic-riverine ecotone found at Tell Abu Hureyra, is the same as that of Tell Mureybat, Nahr el-Homr, and Dibsi Faraj East. The cultural assemblages from all but Nahr el-Homr are similar, suggesting that they represent a single cultural entity, with Tell Abu Hureyra Levels 280- 330, Trench E, and Dibsi Faraj East being older than Tell Mureybat. The Nahr el-Homr assemblage appears to be mixture of several time periods. The materials from the el-Kowm area do not fit the pattern of Tell Abu Hureyra, Tell Mureybat, and Dibsi Faraj East as well. This may be a factor of the nonriverine location of the el-Kowm area or the possibly earlier age of the el-Kowm industries in the late Epipaleolithic sequence.

CHAPTER 5

THE CHIPPED STONE FROM THE LATE EPIPALEOLITHIC AT TELL ABU HUREYRA

The late Epipaleolithic component at Tell Abu Hureyra was located in Trench E and was represented in the excavations by levels 252 through 330. Artifacts from these levels were recovered, as previously discussed, by both dry sieving and froth flotation residues. Analysis of the chipped stone revealed that some Neolithic elements were present in the late Epipaleolithic industry. This was probably the result of disturbance caused by rodent activity.

Initially, two radiocarbon dates were obtained for the late Epipaleolithic occupation. These are 9,210 ± 110 b.c. (BM-1718) for level 303 and 8,842 ± 82 b.c. (BM-1121) for a composite sample from levels 264, 265, 266, 267, 281, and 307 (Burleigh, Ambers et al. 1982:284; Burleigh, Matthews, et al. 1982:253). A recent series of radiocarbon dates suggests that the late Epipaleolithic occupation at Tell Abu Hureyra spans the period form about 9,100 to 8,300 b.c. (Moore 1985 personal communication). The chipped stone assemblage described in this chapter is that from levels 280 through 330, and represents approximately the lower one-half of the late Epipaleolithic occupational deposit in Trench E. These materials probably span the period from about 9,000 to 8,600 b.c.

Typology

There are three basic typologies that have been used for the late Epipaleolithic in the Near East in the past twenty years. The first of these was the typology formulated by Tixier (1963) for the Epipaleolithic of the Maghreb of northern Africa. Tixier's typology has been very useful in providing a basic outline for microlithic-based industries, although some tool types do not have parallels in the Near Eastern Epipaleolithic. Thus, for example, the aiguillon droit and several of the specialized point types, such as the Aiqun Berriche, Chacal, or Mechta el-Arbi points, are not found in the Levant (Tixier 1963:97, Fig. 34, nos. 20-25; 100, Fig. 35, nos. 1-3, 9-11). Most of the other tool categories, such as scrapers, burins, backed blades, notches, denticulates, truncations, and others, are found in Near Eastern collections.

Tixier (1963:7) based the organization and some definitions within his typology upon the earlier work by de Sonneville-Bordes and Perrot (1954-1956) for the Upper Paleolithic of Western Europe. The typology formulated by de Sonneville-Bordes and Perrot was, in turn, heavily influenced by the earlier work of Bordes (1961) on the Lower and Middle Paleolithic. Bordes' work, as the first widely accepted system of standardization of lithic description, was a landmark study in the classification of chipped stone. Thus, it had a strong influence on subsequent taxonomic systems formulated by French prehistorians.

Tixier's typology has served as the foundation for all subsequent classification of the Epipaleolithic in the Levant. Marks (1976a:371-383) borrows heavily from Tixier, with only minor modifications in some definitions, such as piquant-trièdre and scalene bladelet.

Bar-Yosef (1970a) also utilized Tixier as a basic starting point. However, Bar-Yosef differs in his approach in three major aspects. First, Bar-Yosef frequently subdivides tool types by proportional width, such as "broad carinated" versus "narrow carinated" scraper on thick flake, or "narrow" versus "broad" micropoint (Bar-Yosef 1970a:19). Presumably, the "proto" definition is based on the ability to recognize microliths that are close to certain geometric forms. The concept of "proto-geometric" is probably much easier to apply on paper than in practice, since it attempts to subdivide a continuous range of shape from trapeze to triangle to lunate. In this context, it must be noted that Bar-Yosef's typology was specifically designed to allow classification of early Epipaleolithic assemblages where a nongeometric industry, the Kebaran, evolved into the geometric industry of the Geometric Kebaran A. And third, Bar-Yosef's typology also emphasizes the positioning of the retouch on blades and bladelets. Thus, the typology incudes blades that are retouched on both sides (type 39), pointed bladelets that are retouched on both sides (type 54), and alternately retouched bladelets (type 55). There are also several other types added to the basic Maghreb typology. These include the el-Wad point (formerly called a Font Yves point), the Falita point, micropoints, and sickle blades.

The most recently proposed typology is that published by Hours (1974), which is based on the consensus opinions of a symposium on terminology held in London in 1969. The outline of the typology is specifically addressed to sites in Lebanon. The basic major tool classes are the same as those proposed by Tixier and Bar-Yosef. However, the nongeometric and geometric microlith tool classes are divided into types classified not only by their morphology, but also by the retouch style. Thus, for example, there are pointed bladelets with abrupt retouch, pointed bladelets with fine retouch, bladelets with Helwan retouch, short abruptly retouched isosceles or scalene triangles, and elongated scalene triangles with abrupt retouch (Hours 1974:6-7).

The classification of tool types by both form and retouch necessarily creates a very large tool list, which can be cumbersome to utilize. However, since some retouch styles like Helwan have been seen as chronological markers, it may be important to use an expanded list to help determine whether particular sequences from regions or sites can be subdivided into meaningful units. The use of this kind of type list would be dictated by the circumstances surrounding the materials examined, such as whether detailed stratigraphic control was maintained at a particular site or sites, and whether or not more than one retouch style was used on microliths. In the absence of reliable and detailed absolute chronological evidence, the ability to recognize changes through time in percentages of different microliths in conjunction with retouch style may be the only practical way to distinguish chronological developments. As discussed in Chapter 2, this method has been successfully employed by Hours and Loiselet (1975-1977) at Jiita II for tracing the Kebaran development in Lebanon.

Henry (1973b, 1976, 1982) has opted for a generalized approach to classification in the Near East. Essentially, he has reduced tool types and classes into several broad categories, such as retouched pieces, scrapers on flakes and blades, geometric microliths, and notched and denticulated pieces. His categories include the major classes for which percentages and numbers are published in the literature. As a broad approach, this is useful for general comparisons of similar assemblages.

In recent years, Tixier has modified his original typology (Inizan and Tixier 1980). Basically, this resulted in the reduction of the number of types in the burin class, in the backed bladelet class, and in the elimination of spontaneous retouch. Inizan and Tixier have proposed the creation of a short list, much as Hours (1974) did, which can be modified by the addition of tool types which are significant or meaningful in particular assemblages.

The manufacturing processes that resulted in the final forms of the tools present in the assemblages reflect technological patterns, and sometimes stylistic preferences. These differences in the production of assemblages allow separation of tool assemblages into industrial complexes. The end products, or tools, classified by archaeologists, represent various stages of reduction of blanks and cores. These have archaeological meaning if they can be shown to conform to distinct patterns of reduction practiced by particular prehistoric groups that are restricted in space and time. These patterns may have been related to the dictates of raw material availability, quality and size, to functional needs, to the types of resources exploited within a given econiche, or to purely stylistic preferences. They are useful because, as reflections of learned behavior, they allow one to trace cultural relationships across space and through time.

In order to achieve comparability with other Levantine industries, the classification used for the late Epipaleolithic chipped stone industry from Tell Abu Hureyra was based in both principle and outline on the typology proposed by Tixier (1963), since Tixier's approach has been widely applied to most assemblages from the Levant. Tixier's typology is not always directly suitable for the northern Syrian materials. Many of Tixier's types were applied to the Tell Abu Hureyra collections on the basis of an initial survey of the range of tools. These types were then cross checked with the typology formulated by Bar-Yosef, since his typology was specifically designed for the Levant. At this point, and with the knowledge from the initial survey of Tell Abu Hureya tools, several categories employed by Bar-Yosef were added to the type list, including the distinction between perforators and borers. Finally, as with any typology derived from another area, some additional types had to be created. At Tell Abu Hureyra, these included gouges, axes, and blunted implements.

Unlike some assemblages from other areas and other temporal periods, the Tell Abu Hureyra collection contained a restricted array of both nongeometric and geometric microliths. These were characterized by a predominance of abrupt retouch, and by smaller amount of anvil retouch. Since the majority of the microliths were abruptly retouched and no Helwan retouch was present, it was felt that Hour's (1974) expanded tool list was inappropriate for the types of problems addressed by this research.

The final tool typology utilized is presented in Appendix A. All definitions (Appendix B) are from Tixier (1963) with the following exceptions. Following Bar-Yosef (1970a:Fig. 8, nos. 92, 93), a distinciton is made between perforators and borers. Perforators are considered to be thin, sharp pointed implements, while borers are thick, blunt pointed implements. Both may be formed by abrupt retouch (Appendix B, Figs. B-6, B-7). In some respects, the borer is similar to the <u>mèche de foret</u> of Tixier. The dihedral burin includes angle, straight and offset types. A category of burins formed with the burin blow originated from the striking platform of the flake or blade was recognized. This category has no parallel in either Tixier's or Bar-Yosef's typologies. This category has no parallel in either Tixier's or Bar-Yosef's typologies. All backed bladelet fragments lacking the distal end were placed in the "fragments" type. This procedure is unlike that followed by Tixier, in which many of these are placed in the "pointed straight" bladelet type. It was felt that, without the distal end, placing such fragments into a specific tool type would lead to disproportionately large frequencies in that type. Finally, the tool types of gouges, axes, and blunted implements were recognized. (Appendix B, Figs. B-19 to B-27). The gouges are reminiscent of the <u>erminette</u> type described by the Cauvins for Tell Mureybat (J. Cauvin 1978:90, Fig. 16, no. 1). The blunted implements are somewhat like picks. These may be either a specilized form of heavy implement or exhausted gouges and axes. The axes are characterized by tranchet sharpening blows from one or both sides that create a more or less flat, sharp edge.

<u>Chipped Stone at Tell Abu Hureyra</u>

The counts and percentages in the typological classification of the chipped stone from Trench E, levels 280-330, at Tell Abu Hureyra are summarized in Appendix A. Figures B-1 to B-30 in Appendix B show representative tools. The most prominent tool category is that of notches and denticulates (19.7%), followed by scrapers (16.7%), geometric microliths (13.1%), retouched pieces (10.3%), and nongeometric microliths (9.7%). The notch-denticulate class is dominated by notched flakes. These are followed by lesser quantities of denticulated flakes and notched blades and bladelets.

The scraper category is mainly composed of scrapers on flakes (60.5% of all scrapers). By contrast, scrapers on blades make up only 2.7% of the scraper class. Interesting enough, the second largest scraper type is that of denticulated scrapers. This may be a further emphasis on the apparent importance of notched and denticulated implements at Tell Abu Hureyra. Well over half of the scraper category was manufactured on blanks other than noncortical flakes, blades or bladelets. Of the 406 scrapers, 261 were fashioned on cortical flakes, flakes with some cortex, core rejuvenation flakes, or cores. This gives the scraper class a "heavy" tool orientation, since these types of blanks tend to be thick and large.

The geometric microlith class consists almost exclusively of lunates, which represent 86.6% of this class. A few trapezes and triangles are present, but these may in fact be mostly improperly formed lunates rather than deliberate trapezes and triangles, as suggested by Moore (1975b:58).

Nongeometric microliths also represent a small portion of the tool assemblage, and are restricted in the number of types present. Some of these such as the "backed and truncated" may represent forms leading to the trapeze/rectangle microlith. The class of nongeometric microliths is the trapeze/rectagle microlith. The class of nongeometric microliths is dominated by the pointed straight type. Other well represented types are bladelets with convex backed ends (tips), partially backed bladelets, blunt distal end bladelets, double backed bladelets, and convex backed bladelets. Rare forms include bladelets with undulating backs, and backed and truncated types.

The tool assemblage from Tell Abu Hureyra also contains a small percentage of perforators and borers. The distinction between perforators and borers is that provided in illustrations by Bar-Yosef (1970a: Fig. 8, nos. 92,93).

The burin class is mainly composed of burins struck from the striking platforms, from natural edges, and from breaks, and dihedral burins. Burins on truncations, are also fairly numerous. Rare forms include multiple burins on truncations, other multiple burins, core-like burins, and transverse burins stuck from lateral preparation.

The backed flake and blade category is dominated by backed flakes. Other common forms are blades with straight backed edges, with convex backed ends (tips), with convex backs, double backed, and partially backed. Less common forms are blades with undulating backs and with a blunt distal end.

The truncation class includes mainly oblique and straight truncations.

The heavy tool class is dominated by the gouges, axes and blunted implements which comprise 43 of the 55 heavy tools. These tools represent 1.7% of the entire tool collection, suggesting that they had a limited, but possibly significant role at Tell Abu Hureyra. Broken heavy tools are usually unclassified since the working edge portions are missing. Thus, these are referred to as "heavy tool" fragments. Of the 25 complete specimens, 4 are blunted end types, 12 resemble gouges or simple versions of the erminette found by the Cauvins (J. Cauvin 1978:90, Fig. 16, no. 1) at Tell Mureybat Ia, and 9 resemble axe edges, by virtue of the convergence of tranchet sharpening flakes which were bifacially removed. The term erminette is used for the Tell Abu Hureyra gouges only as an indicator of general resemblance, since it is felt that the term should be reserved for the fully developed distinctive pattern seen at Tell Mureybat.

A variety of composite tools exist. These include scraper-denticulates and scraper-burins as the most common types. Rarer composite tools are scraper-borer/perforator, scraper-chopper, notch-sidescraper, perforator/borer-truncation, perforator/borer-burin, multiple burin-notch, and chopper-notch.

Among the Various class, the most common tool type was the sidescraper. Sidescrapers were placed in the Various category to maintain consistency in description since most previously published descriptions of late Epipaleolithic tool assemblages have listed sidescrapers under various tools. The relatively large number of sidescrapers is not an unexpected development considering the high proportion of other scrapers found at Tell Abu Hureyra. Other tool types in the Various category are miscellaneous backed pieces, naturally backed knives, and a few intrusive Neolithic arrowheads.

Retouched pieces are blanks with noncontinuous retouch along one or more edges of the piece and, extending at a minimum, for at least one-third of one edge of the blank. Aside from the presence of retouch, this tool class exhibits no patterning with respect to retouch type or morphology of the blank. It may represent a class of ad-hoc or informal tools, used briefly for a minimum of tasks. The fact that these retouched pieces compose 10.3% of the tool assemblage at Tell Abu Hureyra, suggests that they played a limited, but significant role in prehistoric activities.

One other retouched category was separated out. This included debitage with marginal or nibbling type retouch.

Since it is uncertain whether or not this retouch is the product of use, of accidental chipping (as can result from damage on the ground or in transport), or of spontaneous retouch (Newcomer 1976), these were not recognized as tools within the formal typological framework.

The debitage (Appendix A) from Tell Abu Hureyra is dominated by flakes of various types. Blades and bladelets represent only a minor portion. Debris (chips, chunks and shatter) are also present in sub-stantial numbers. Flake types show large numbers of cortical flakes, flakes with some cortex, and noncortical flakes, as well as numerous core rejuvenation flakes. This suggests that the cores were worked at the site, rather than at a quarry area, and that the raw material source was probably close at hand. In fact, Moore (1975b:68) states that flint is locally available on the surface of the steppe and in the wadis around Tell Abu Hureyra. This flint is found in the form of river cobbles presumably derived from the Pleistocene terraces of the Euphrates River. Large numbers of micro flakes, those flakes obtained in the process of sharpening or resharpening tools, were also present. This indicates that tool production and maintenance also occurred at the site. The blank types found in the blade and bladelet debitage also reflect the pattern of reduction which occurred at the site.

The microburins represent a very small percentage (0.08%) of the debitage. The small numbers (N=30) of true microburins suggest that the microburins technique was not commonly employed at Tell Abu Hureyra. This is supported by the ratios of microburins to microliths (1:18.5) and microburins to noncortical blades and bladelets (1:69). The somewhat larger number of Krukowski micorburins (N=59), usually defined as accidental by-products, presents an interesting parallel to the Geometric Kebaran A industry of the southern Levant. It may be that the Krukowski microburin is the by-product of the process of retouching microlithis using the anvil technique, especially since both abrupt and anvil type retouch can be produced using an anvil.

Over half (59.6%) of the cores are either single platform or polyhedral types (Appendix A). In addition, the core assemblage indicates that most of the technological orientation of chipped stone production at Tell Abu Hureyra was toward flakes (79.2%) despite the fact that most, if not all, microliths were fashioned on bladelets. The flake cores are predominently single platform or polyhedral varieties, while the blade and bladelet cores are generally single platform (Appendix B, Figs.B-31-B-38).

Hammerstones are present, as well as cores used as hammerstones (Appendix A).

Possible Functions of the Tell Abu Hureyra Lithics

The chipped stone tool classes of notches and denticulates, scrapers, and microliths, at Tell Abu Hureyra, account for over 59% of the tool assemblage. Their numbers probably reflect an emphasis on particular activities. Techniques of analysis of microwear for the interpretation of function and use of lithic materials employing both low level magnification (Keeley 1980) and high power magnification (Anderson 1980) have recently been used with varying success to identify types of polish on tool edges and plant phytolith bodies that have become trapped on the edges of tools.

To date, only one microwear study involving north Syrian late Epipaleolithic chipped stone has been published (Anderson-Gerfaud 1983). The results of this study, discussed later, in conjunction with such studies on Natufian assemblages, suggest that these types of analyses may have general applicability for the interpretation of tool function in many Levantine late Epipaleolithic assemblages.

Preliminary microscopic studies of 21 endscrapers from Neolithic levels at Sefunim in Israel (Büller n.d.:13, Table IV) suggests that they were used on both bone and hide. The idea of scrapers used to scrape hides is by no means a new one, but signs of use on bone point to their potential for multiple tasks.

A sample of 10 notches from Mugharet el-Wad and 10 notches from Ain Mallaha from the Natufian levels, were also examined for microwear by Büller (1982:8). Those from Mugharet el-Wad were used primarily on sinew, while those from Ain Mallaha showed seven different types of microwear, indicating that they were multipurpose tools.

Büller (1982:9-10) also examined a series of microliths from Mugharet el-Wad and Ain Mallaha. The nongeometric microliths showed both meat microwear and hafting in bone and wood hafts. The lunates from both sites showed meat microwear and hafting in bone. Evidence has also shown microliths to be frequently hafted and used as projectile points (Clark 1975-1977:137, Plate IIIA, no 3, Plate IV, no 3; Clark, Phillips and Stanley 1974:335, Plate IV, 336, Plate V). Microliths have been found in archaeological deposits hafted in sickle hafts, as at Mugharet el-Wad (Garrod and Bate 1937:Plate XIII, Fig. 1, no. 2).

A recent study of a small sample of lunates from Tell Abu Hureyra and lunates and triangles from Tell Mureybat by Anderson-Gerfaud (1983) indicates that these tools had functions similar to those from the Natufian assemblages. Thus, the sample of large lunates and triangles from Tell Mureybat Ia showed fresh hide or meat polish, with abrasion traces perpendicular and oblique to the distal tip. Based on a comparison with similar microliths used experimentally and with Danish transverse arrowhead, Anderson-Gerfaud (1983:81) suggests that these tools, at Tell Mureybat, were hafted as transverse arrowheads. The smaller lunates and triangles from Tell Mureybat Ia also showed similar microwear. One of those examined was pobably hafted as a barb, the others as arrow tips (Anderson-Gerfaud 1983:81-82).

The sample from Tell Abu Hureyra (Level 308) showed that one large lunate was probably hafted as a transverse arrowhead, while the other two were arrow tips, in which one tip was hafted while the other served as the arrowtip (Anderson-Gerfaud 1983:82-83). However, as will be discussed in Chapter 6, probably not all lunates from Tell Abu Hureyra served as arrowheads or arrow barbs.

In addition to geometrically shaped tools, Anderson-Gerfaud also examined a sample of "lustred" tools from Tell Mureybat and Tell Abu Hureyra. The Tell Mureybat Ia showed that they had been most likely used to cut sedges and rushes for fuel, basketry and thatching, rather than wild cereal grasses (Anderson-Gerfaud 1983:95). The two tools examined from Tell Abu Hureyra shouwed that they were probably used to cut <u>Stipa</u> (Anderson-Gerfaud 1983:96). The microwear traces indicate that the tools were used to cut somewhat dry stems of <u>Stipa</u>, thus suggesting that these were materials for fuel, basketry and thatching.

Anderson-Gerfaud (1983:90) points out that experiments to date have shown that different types of polish can be distinguished for einkorn wheat, emmer wheat, pasture grass, rushes, reeds, and borage. This will perhaps enable distinction of tool edges used for harvesting food plants as opposed to those used to cut materials for nonfood purposes. As Anderson-Gerfaud (1983:97) suggests, this distinction may be invaluable in assessing the role of sickle blades in Natufain contexts.

Burins are the tool class that has received the most attention in microwear analysis. Studies by Büller (1982;n.d.) have shown that burin bits are not always the focus of use. In the Neolithic levels at Sefunim (Büeller n.d.:5), a sample of 12 burins showed only three with the burin bit used as the tool (two on bone and one on hide). Five of the burin bits were utilized as the hafted end in bone and wood hafts. Büller suggests that these burin blows served as a blunting technique enabling them to be hand-held. At Mugharet el-Wad and Ain Mallaha, in the Natufian levels, the burin blow was found to be a technique to blunt the sharp edge of a blank (Büller 1982:6-7), much as abruptly retouching an edge would serve to blunt that edge. The importance of recognizing hafting microwear has been recently pointed out by Keeley (1982). In contrast to Büller's work, studies by Moss (1977,1982) on burins from the aceramic Neolithic levels at Tell Abu Hureyra, suggest that there, burin bits were intended for use on hard materials, primarily in the activities of engraving and boring.

Thus, the microwear analyses done to date on Levantine tool types dating to the late Epipaleolithic and Neolithic show that many of the microlithic types were used primarily on meat, hide and bone. The small sample of "lustred" tools from north Syrian sites indicates that these were used to cut building materials and fuel rather than cereal grasses. These observations of the functions of tools must be tempered by the small numbers of artifacts which have been examined to date, and the types and locations of the sites from which the tools came. In addition, it should also be emphasized that some tool types, such as notches, appear to have had multiple uses at some sites. There is also the problem, not often recognized or acknowledged by microwear studies, of whether or not multiple uses of the same tool disguise all but the last usage of the tool.

Comparison to Other Northern Syrian Sites

The chipped stone collections from Phase Ia at Tell Mureybat have not yet been published in full detail. This assmeblage has been dated to about 8,300 b.c. in its final stages (M.-C. Cauvin 1980:17). Thus, it is considerably later than the assemblage from Tell Abu Hureyra (Trench E, Levels 280 to 330). The brief descriptions of the chipped stone (J. Cauvin 1972, 1974; M.-C. Cauvin 1980) indicates that geometric microliths, predominently lunates, are abundant. These are generally short, averaging 15 mm. in length, and are abruptly backed. There are numerous microperforators and backed bladelets (J. Cauvin 1972:108). In addition, other tool types include perforators, drills (mèches de foret), endscrapers, burins, retouched and denticulated pieces, rare sickle blades, rare picks, and the erminette. Microburins are also present.

Without specific numbers and percentages, a detailed comparison with the Tell Abu Hureyra industry is impossible. However, both collections do contain the same types of tools, including the possible earlier precursor at Tell Abu Hureyra of the erminette at Tell Mureybat. The extremely small numbers of true microburins at Tell Abu Hureyra, and the presence of these at Tell Mureybat, indicates that this technique was known at both sites. To what extent it was employed at Tell Mureybat is uncertain.

The pan-Levantine trend from long to short lunates through time is apparently seen in the succession from Tell Abu Hureyra to Tell Mureybat. Helwan style retouch has not been found at either of these sites, perhaps suggesting that: (1) contact with the southern Levant was sporadic; (2) Helwan style retouch was not accepted at these sites; or (3) Helwan retouch was earlier. The absence of Helwan retouch at Tell Abu Hureyra and Tell Mureybat is an interesting point, since occasional finds of this retouch style have been recorded at other northern Syrian sites.

Tell Abu Hureyra and Tell Mureybat are the only two extensively excavated sites dating to this time period in northern Syria. The few remaining sites are either surface collections or small sondages. A small surface collection exists from the site of Dibsi Faraj East (Wilkinson and Moore 1978). Table 8 lists both the published data and the data obtained when I examined this collection. The two analyses are fairly comparable. As with the materials from Tell Abu Hureyra, lunates from Dibsi Faraj East are long and have abrupt or anvil retouch. Scrapers, notches and denticulates, microliths, and retouched pieces are the most common classes (Appendix C), as at Tell Abu Hureyra. A few true micoburins, backed blades and backed flakes are present. Nine of the sixteen cores are either single platform or polyhedral types. Only six cores are blade or bladelet cores. Thus, the Dibsi Faraj East assemblage appears to resemble the materials from Tell Abu Hureyra (Appendix D, Tables D-1, D-2).

The el-Kowm area has produced some sparse surface remains from the late Epipaleolithic, as well as one test pit recovery of such artifacts (M.-C. Cauvin 1981a; J. Cauvin et al. 1980). At Aarida 7, about a dozen artifacts were surface collected. These included three long lunates with Helwan retouch. At el-Kowm I, in a small test pit, a late Epipaleolithic industry with microburins, Helwan retouched lunates, a triangle, and scrapers were recovered. If M.-C. Cauvin (1981a:387) suggests that the el-Kowm late Epipaleolithic predates that found at Tell Abu Hureyra. This statement was made prior to the recently obtained C-14 date of 9,210 ± 110 b.c. (Burleigh, Ambers et al. 1982:284) for level 303 at Tell Abu Hureyra. If M.-C. Cauvin is correct in assuming the greater antiquity of the el-Kowm collections, then their date must be earlier than 9,100 b.c. A few Helwan lunates were also found at Nahr el-Homr (Boerma and Roodenberg 1977:14).

The chipped stone assemblages from the two excavated sites, Tell Abu Hureyra and Tell Mureybat, as well as the surface collection from Dibsi Faraj East, show many similarities, while assemblages from the el-Kowm area and Nahr el-Homr, appear to be different from those of Tell Abu Hureyra, Tell Mureybat and Dibsi Faraj East. In part, this may reflect the small numbers of collected artifacts from the el-Kowm area, and the possiblity that the surface collections include mixtures of artifacts from several different time periods. However, the Helwan lunate is a marker for the Natufian complex and a generally earlier time period in the southern Levant, and it is found in small numbers in both the el-kowm and Nahr el-Homr areas. Its presence may indicate, as suggested by M.-C. Cauvin, that the el-Kowm area collections are earlier than those from Tell Abu Hureyra.

<u>Patterns of Chipped Stone Tool use During the Levantine Late Epipaleolithic</u>

Several kinds of comparative analyses were applied to both the published data and that acquired through examination of collections. These analyses included computation of

Table 8. Comparison of published and observed counts and percentages for the Dibsi Faraj East assemblage.

	Wilkinson and Moore 1978 Number	%	Olszewski Number	%
Scrapers	20	15.5	15	12.5
Perforator/Borers	5	3.9	7	5.8
Burins	4	3.1	4	3.3
Backed flakes, blades, bladelets	12	9.3	12	10.0
Notches and Denticulates	15	11.6	14	11.7
Truncations	10	7.8	9	7.5
Geometrics	32	24.8	30	25.0
Retouched pieces	28	21.7	26	21.7
Various	3	2.3	3	2.5
Total tools	129		120	
Microburins	5		8	
Cores	17		16	
Debitage	354		358	
Total	505		502	

distance coefficients, cluster analysis, and principal components analysis. The use of generalized tool classes was dictated by the published tool assemblage counts, which often did not delineate specific tool types within classes.

Distance Coefficients

The data used in this portion of the analysis were derived from that presented in Appendix D. Of the twenty sites and levels of sites, only J2 and 406a, both from southern Jordan, were not used in this first analysis, because of extremely small sample sizes. Therefore, the sites constituting the data base were Tell Abu Hureyra, Dibsi Faraj East, Rosh Horesha, Rosh Zin, Black Desert 14/7, Mugharet el-Wad, Mugharet el-Kebarah, Shukbah, el Khiam, Ain Mallaha, and Nahal Oren.

After an initial inspection of the data, many of the tool classes that were not represented at a majority of the sites were eliminated. These included the groups of massive tools and the sickle blades. In addition, the category "Various" was also eliminated, since "Various" was a catch-all category which did not distinguish between the many different types of tools in each tool assemblage. These eliminations reduced the tool categories to the following classes: scrapers, borer/perforators, burins, geometric microliths, nongeometric microliths, and notch/denticulates.

Tables 9 and 10 present the distance measurements and sample sizes of the tool groups used from these sites. There are several aspects of this comparison which require comment. First, the distance coefficients (derived by computing the square root of the sum of the square differences in percentage for each typological category) comparing levels form the same site tend to be smaller than those comparing different sites, for example, as between Mugharet el-Wad Level B1 and B2, Nahal Oren V and VI, and el Khiam 7 and 6. While one might expect such a relationship, it does suggest that emphases placed on particular tool classes at specific sites did not greatly vary over time. This may also imply that the activities for which these tool classes were utilized did not change greatly through time. Thus, specific sites could have been used for the same types of activities over many generations.

On the other hand, the distance coefficients also show relatively low scores for certain pairs of sites, for example, Ain Mallaha and Nahal Oren, Rosh Zin and Dibsi Faraj East, and Rosh Zin and Rosh Horesha. A possible explanation of the similarities between these pairs of tool assemblages may be that they reflect similar adaptations to similar environments.

In a series of comparisons of particular tool classes with the sum of the tool groups from each of the Natufian sites with larger sample sizes (Mugharet el-Wad, Nahal Oren, Ain Mallaha, Rosh Horesha, Rosh Zin, and Shukbah), only the

Table 9. Distance coefficients pair-wise comparisons of Dibsi Faraj East, Mugharet el-Wad, Nahal Oren, Mugharet el-Kebarah, Ain Mallaha, Rosh Horesha, Rosh Zin, el Khiam, Shukbah, and Black Desert 14/7 to Tell Abu Hureyra, Mugharet el-Wad, Nahal Oren, Mugharet el-Kebarah, and Ain Mallaha. --TAH = Tell Abu Hureyra, DF = Dibsi Faraj East, EW = Mugharet el-Wad, NO = Nahal Oren, KB = Mugharet el-Kebarah, MA = Ain Mallaha, HOR = Rosh Horesha, ZIN = Rosh Zin, EK = el Khiam, SH = Shukbah, BD = Black Desert 14/7.

	Distance Coefficient and Combined Sample Size								
Site	TAH	DF	EWB2	EWB1	NOVI	NOV	MA3-4		MA 3
DF	28.3								
	1802								
EWB2	58.8	38.8							
	9178	7520							
EWB1	60.8	39.3	5.5						
	5699	4041	11417						
NOIV	41.3	51.2	52.7	57.1					
	2173	515	7891	4412					
NO V	29.4	38.1	47.1	50.4	18.4				
	2268	610	7986	4507	981				
K B	63.3	49.8	38.2	36.7	65.5	58.6			
	1894	236	7612	4133	607	702			
MA3-4	41.3	57.9	65.7	69.6	16.7	25.2	73.4		
	2267	609	7985	4506	980	1075	701		
MA3	29.5	48.9	63.8	66.9	24.1	19.8	68.3	15.5	
	2200	542	7918	4439	913	1008	634	1007	
MAIb	35.9	52.9	62.0	65.7	15.5	18.9	68.5	9.2	11.1
	2182	524	7900	4421	895	990	616	989	922
HOR	32.5	23.6	37.6	38.2	42.4	26.6	49.9	48.3	39.3
	3944	2286	9662	6183	2657	2752	2378	2751	2684
ZIN	30.3	19.2	36.8	37.2	44.2	29.9	48.5	50.6	41.9
	2669	1011	8387	4908	1382	1477	1103	1476	1409
EK 7	40.8	55.0	70.4	72.9	43.6	43.7	73.4	36.0	34.1
	1925	267	7643	4164	638	733	359	732	665
EK 6	41.1	53.6	69.3	71.4	45.8	44.1	72.2	38.6	35.5
	1992	334	7710	4231	705	800	426	799	732
EK 5	37.1	52.5	63.4	66.9	27.8	32.7	70.0	23.9	26.6
	1903	245	7621	4142	616	711	337	710	643
EK 4	28.8	43.2	59.9	63.0	33.1	33.0	65.5	30.0	27.6
	1960	302	7678	4199	673	768	394	767	700
SH B	46.3	30.9	18.7	20.3	44.7	38.3	32.6	55.2	52.0
	2351	693	8069	4590	1064	1159	785	1158	1091
B D	22.7	41.5	67.7	69.6	45.3	31.6	71.2	44.1	31.0
	1873	215	7591	4112	586	681	307	680	613

Table 10. Distance coefficients pair-wise comparisons of Ain Mallaha Ib, Rosh Horesha, Rosh Zin, el Khiam, Shukbah, and Black Desert 14/7 to Tell Abu Hureyra, Ain Mallaha Ib, Rosh Horesha, Rosh Zin, el Khiam and Shukbah. -- TAH = Tell Abu Hureyra, MA = Ain Mallaha, HOR = Rosh Horesha, Zin = Rosh Zin, EK = el Khiam, SH = Shukbah, BD = Black Desert 14/7.

	Distance Coefficient and Combined Sample Size								
Site	TAH	MAIb	HOR	ZIN	EK 7	EK 6	EK 5	EK 4	SH B
MAI b	35.9 2182								
HOR	32.5 3944	43.1 2666							
ZIN	30.3 2669	45.1 1391	11.0 3153						
EK 7	40.8 1925	37.5 647	50.2 2409	47.7 1134					
EK 6	41.1 1992	39.8 714	47.7 2476	45.7 1201	6.2 457				
EK 5	37.1 1903	24.3 625	48.0 2387	45.2 1112	20.9 368	25.5 435			
EK 4	28.8 1960	29.5 682	43.0 2444	39.5 1169	18.9 425	22.4 492	13.8 403		
SH B	46.3 2351	51.0 1073	30.1 2835	26.0 1560	55.2 816	54.4 883	48.9 794	44.9 851	
B D	22.7 1873	37.1 595	39.2 2357	40.5 1082	54.5 338	55.0 405	47.9 316	43.5 373	57.0 764

comparison of borer/perforators with the sum of all tools appeared to suggest a real relationship (Table 11). Here, the high correlation coefficient for absolute frequencies suggested that the number of borer/perforators in any given assemblage might have a positive linear relationship with the sum of all tools. This would indicate that the manufacture of borer/perforators was directly related to the total number of tools in all of these Natufian assemblages. However, as Figure 14 shows, the strength of this linear relationship is heavily influenced by the large assemblage from Mugharet el-Wad B2. Despite this, the other large assemblages appear to follow the same regression line suggesting the presence of a real relationship.

Thus, while the result of this initial analysis did not conclusively demonstrate clear relationships between pairs of sites or between tool classes, it did suggest that different levels of some sites shared similar tool assemblages. It also suggested that in those assemblages tested, the absolute frequency of one tool class (borer/perforators) may simply reflect the total quantity of tools being produced.

Cluster Analysis

Based on the first analysis, it was felt that further comparative examinations of the late Epipaleolithic tool assemblages from the Levant might provide additional insight into possible relationships. The tool classes of scrapers, borer/perforators, burins, geometric microliths, nongeometric microliths, and notch/denticulates were again used. However, for the cluster analysis, the tools represented by these groups were considered to be the total sample of tools from each site. Thus, the percentages calculated for each tool group, and used as a method of standardization, sum to 100% for each site. In addition, the sites of Hayonim Cave and the Hayonim Terrace were added to the sample, as well as J2 and 406a from southern Jordan.

The cluster analysis used was the Biomedical Statistical Program 2M (Engleman 1983) for the cluster analysis of cases. The data base consisted of the tool group percentages for each site (Table 12). The method chosen for linking the clusters was the centroid linkage algorithm. This method computed the distance between each pair of cases, and joined the two closest cases. When two cases were joined, a new centroid was calculated by averaging the coordinates of each variable. Thus, distances were measured from this centroid to other cases for membership. The number of cases was thereby reduced by one at each step, and the number of cases in each cluster was used as a weight in the clustering (Engleman 1983:459).

The results of this cluster analysis are illustrated in Figure 15. There are several observations which can be made. Although the data set used in this analysis is not

Table 11. Comparison of borer/perforators to the sum of tools from Natufian sites (Mugharet el-Wad, Nahal Oren, Ain Mallaha, Rosh Horesha, Rosh Zin, and Shukbah).

Site	Sample Size	Ratio	9 Degrees of Freedom Ordered Ratios
EW B2	7872	0.03	0.01
EW B1	4245	0.03	0.02
NO VI	531	0.02	0.02
NO V	747	0.02	0.02
MA 3-4	774	0.03	0.03
MA 3	715	0.04	0.03
MA 1b	655	0.03	0.03
HOR	3220	0.01	0.03
ZIN	1241	0.02	0.04
SH B	875	0.04	0.04

Correlation Coefficient from absolute values
$r = .9723$
$r2 = .9454$

Distance Coefficient = 9425
G-Square = 36.907
Chi-square = 34.151

Correlation of Ratios with sample size r = -.0366

Ratio Median = 0.027
Ratio Mean = 0.028
Ratio Dispersion = .6336

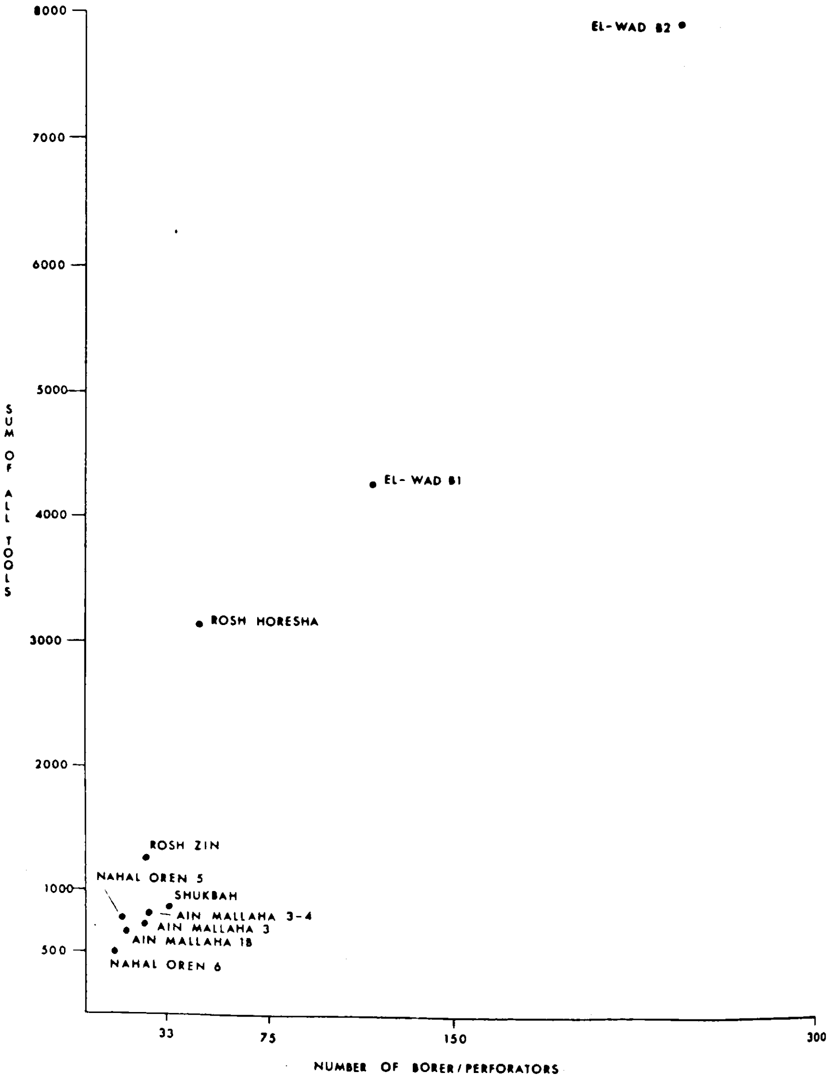


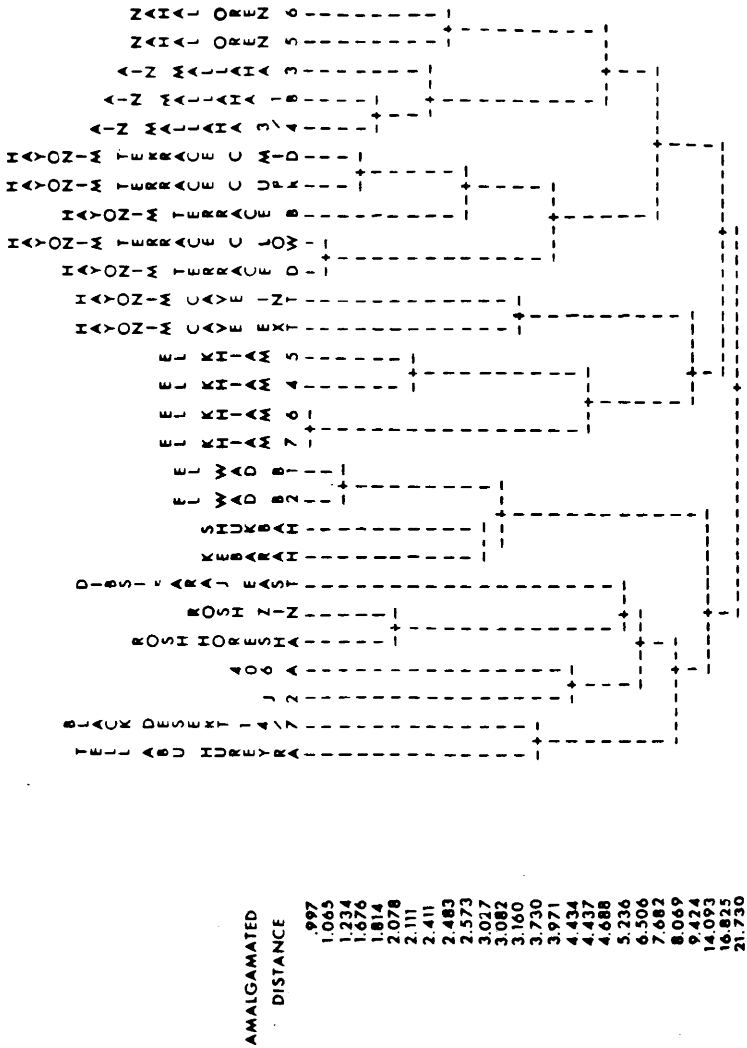
Figure 14. Scatter plot of borer/perforators against the sum of all tools for Mugharet el-Wad, Nahal Oren, Ain Mallaha, Rosh Horesha, Rosh Zin, and Shukbah.

Table 12. Raw data and percentages for selected tool groups from Levantine late Epipaleolithic sites.

-- N = Tell Abu Hureyra 1731; Dibsi Faraj East 72; Mugharet el-Wad B2 6818; Mugharet el-Wad B1 3575, Nahal Oren VI 441; Nahal Oren V 532; Mugharet el-Kebarah 100; Ain Mallaha III-IV 531; Ain Mallaha III 454; Ain Mallaha Ib 445; Rosh Horesha 2195; Rosh Zin 933; El Khiam 7 195; El Khiam 6 262; el Khiam 5 173; el Khiam 4 230; Shukbah B 557; Black Desert 14/7 142; J2 58; 406a 44; Hayonim Cave interior 238; Hayonim Cave exterior 166; Hayonim Terrace D 171; Hayonim Terrace C lower 202; Hayonim Terrace C middle 149; Hayonim Terrace C upper 239; Hayonim Terrace B 81.

Site	Scrapers		Borer/Perf		Burin		Geo		Nongeo		Notch/Dent	
	#	%	#	%	#	%	#	%	#	%	#	%
Tell Abu Hureyra	406	23.5	138	7.8	151	8.7	320	18.5	236	13.8	480	27.7
Dibsi Faraj East	15	20.8	7	9.7	4	5.6	30	41.7	2	2.8	14	19.4
Mugharet el-Wad B2	129	1.9	238	3.5	174	2.5	5050	74.1	1193	17.5	34	0.5
Mugharet el-Wad B1	39	1.1	117	3.3	123	3.4	2800	78.3	453	12.7	43	1.2
Nahal Oren VI	11	2.5	12	2.7	46	10.4	117	26.5	199	45.1	56	12.7
Nahal Oren V	11	2.1	16	3.0	61	11.5	157	29.5	163	30.6	124	23.3
Mugharet el-Kebarah	5	5.0	3	3.0	4	4.0	83	83.0	5	5.0	0	0.0
Ain Mallaha III-IV	20	3.8	26	4.9	106	19.9	58	10.9	240	45.2	81	15.3
Ain Mallaha III	28	6.2	25	5.5	92	20.3	45	9.9	152	33.4	112	24.7
Ain Mallaha Ib	13	2.9	17	3.8	68	15.3	78	17.5	180	40.4	89	20.0
Rosh Horesha	86	3.9	47	2.1	392	17.9	962	43.8	191	8.7	517	23.6
Rosh Zin	89	9.5	24	2.6	128	13.7	458	49.1	52	5.6	182	19.5
el Khiam 7	40	20.5	10	5.1	66	33.8	32	16.4	43	22.0	4	2.1
el Khiam 6	51	19.5	10	3.8	98	37.4	47	17.9	48	18.3	8	3.1
el Khiam 5	27	15.6	9	5.2	31	17.9	40	23.1	58	33.5	8	4.6
el Khiam 4	49	21.3	25	10.9	41	17.8	46	20.0	57	24.8	12	5.2
Shukbah B	38	6.8	34	6.1	35	6.3	366	65.7	79	14.2	5	0.9
Black Desert 14/7	13	9.2	20	14.1	6	4.2	19	13.4	23	16.2	61	42.9
J2, So. Jordan	3	5.2	0	0.0	1	1.7	24	41.4	6	10.3	24	41.4
406a, So. Jordan	1	2.3	3	6.8	0	0.0	24	54.5	7	15.9	9	20.5
Hayonim Cave, interior	59	24.8	0	0.0	86	36.1	31	13.0	13	5.5	49	20.6
Hayonim Cave, exterior	41	24.7	0	0.0	82	49.4	5	3.0	14	8.4	24	14.5
Hayonim Terrace D	17	9.9	2	1.2	6	3.5	24	14.0	105	61.4	17	9.9
Hayonim Terrace C lower	14	6.9	3	1.5	9	4.5	32	15.8	119	58.9	25	12.4
Hayonim Terrace C middle	10	6.7	1	0.7	4	2.7	33	22.1	74	49.7	27	18.1
Hayonim Terrace C upper	18	7.5	2	1.3	15	6.3	44	18.4	106	44.3	54	22.6
Hayonim Terrace B	8	9.9	3	3.7	1	1.2	18	22.2	32	39.5	19	23.5

Figure 15. Cluster diagram of clusters formed by Levantine late Epipaleolithic site assemblages.



identical to that used by Henry (1973b:178-179), several similar clusters occur here. As in Henry's analysis, Mugharet el-Wad Levels B1 and B2 and Shukbah clustered, as did Rosh Horesha and Rosh Zin. The assemblages from Hayonim Cave (interior and exterior) were separated from the other two groups. Discussions presented previously have indicated that Henry interpreted these clusters as representative of macroenvironmental zones.

In general, Henry's interpretation appears to be correct. The addition of sites documented since Henry's disseration research, for example, Tell Abu Hureyra, the Hayonim Terrace, and 14/7 in the Black Desert, appears to substantiate the fact that sites in particular macro-environmental zones tend to cluster together. Thus, for example, the steppic sites of Tell Abu Hureyra, Dibsi Faraj East, 14/7 in the Black Desert, J2 and 406a in southern Jordan, Rosh Horesha and Rosh Zin in the Negev Desert, all form one cluster. This is in contrast to the Mediterranean forest zone cluster of the Hayonim Terrace, Ain Mallaha, and Nahal Oren.

There are two particular anomalies in the cluster diagram presented in Figure 15. The underlying factors behind the first of these, the cluster of Mugharet el-Wad and Shukbah, and Mugharet el-Kebarah, has been previously discussed (Chap.3). Briefly, this cluster may have occurred not because of a similar macroenvironment, but because all three sites were excavated at a time when excavation techniques and recovery methods were not as sophisticated as they are today. In addition, these sites were excavated by individuals working in close association with one another, D. A. E. Garrod and F. Turville-Petre. If the hypothesis of the close association of tool assemblages and macroenvironments is correct, then the asemblages from Mugharet el-Wad and Mugharet el-Kebarah, and perhaps Shukbah, should, on an intuitive level, be associated with the Mediterranean forest group.

Alternatively, it is possible that activities at Mugharet el-Wad, Shukbah, and Mugharet el-Kebarah differed from those at Nahal Oren, the Hayonim Terrace and Ain Mallaha. The investigation of this alternative would require information concerning tool assemblages, chronological associations and environmental reconstruction that are not currently available in the literature.

The second anomaly in Figure 15 is the clustering of el Khiam and Hayonim Cave. Logically, one would expect the Hayonim Cave assemblages to be more closely related to those from the Hayonim Terrace. However, as discussed previously, the Hayonim Cave area might have been used as a specialized activity area. The resulting tool assemblages from Hayonim Cave may thus have been highly biased in favor of particular tool classes; in this case, burins and scrapers. On the other hand, the context of the el Khiam materials, as mentioned before, has been questioned. This suggests that there may be problems in the interpretation of the tool assemblages from el Khiam that are attributed to the late Epipaleolithic.

The cluster diagram in Figure 15 also parallels the information derived from the distance coefficients in Tables 9 and 10. However, the cluster analysis shows a closer linkage between Mugharet el-Kebarah and Shukbah than was indicated by the distance coefficients for pairs of sites. This may be the result of the fact that the Mugharet el-Kebarah assemblage is more similar to that from Shukbah than it is to any of the other samples (Table 9). In addition, both Shukbah and Mugharet el-Kebarah have relatively more scrapers and burins than do the two levels from Mugharet el-Wad. As will be discussed below, scrapers and burins are an important selection factor for the clustering of sites.

This cluster analysis indicates that, in general, Henry's hypothesis of the interrelationship of tool assemblages and macroenvioronments is probably correct, and upholds the distance relationships between most pairs of sites seen in the distance coefficients. There are several additional questions that may be raised at this point. These include determinations of the tool classes characteristic of each cluster, of the similarity or dissimilarity of total tool assemblages from sites within each cluster, and of the extent of the relationship of all the analyzed Levantine late Epipaleolithic assemblages.

Principal Components Analysis

A principal components analysis was run to ascertain which tool classes, if any, were associated. If associations could be found, these might relate to the cluster formed in the previous analysis. The percentages presented in Table 12 were used as the data base. The Biomedical Statistical Program 4M (factor analysis) (Frane, Jennrich and Simpson 1983) was used. The principal components analysis method of initial factor extractions was chosen. Principal components analysis is often recommended for the first analysis (Frane et al 1983:486). The factors were related by the Varimax method that simplifies the columns of the loading matrix.

Table 13 presents the data relating to those factors with eigenvalues greater than 1.0. As can be seen, in terms of positive relationships, Factor 1 consists mainly of burins and scrapers, Factor 2 of nongeometric microliths, and Factor 3 of notch/denticulates and borer/perforators. This analysis method was used rather than cumulative graph presentations since such graphs are difficult to assess when the tool group variations are a matter of relatively higher or lower percentages compared across 27 sites and levels of sites. The question of whether or not these factors reflect the cluster groups of the preceding analysis can now be addressed.

The comparison of the percentage data in Table 12 shows that

Table 13. Principal components analysis, break-down of factors with eigenvalues greater than 1.0.

Sorted Rotated Factor Loadings (Pattern)		Factor 1	Factor 2	Factor 3
Burin	4	.900	0.000	-.253
Scraper	2	.885	0.000	0.000
Nongeometric	6	0.000	.900	0.000
Geometric	5	-.644	-.652	-.390
Notch	7	0.000	0.000	.816
Borer	3	0.000	-.462	.646
	VP	2.049	1.530	1.311

The above factor loading matrix has been rearranged so that the columns appear in decreasing order of variance explained by factors. The rows have been rearranged so that for each successive factor, loadings greater than .5000 appear first, loadings less than .2500 have been replaced by zero.

relative to other sites, burin and scraper percentages (Factor 1) are higher for the levels from el Khiam and for the areas of Haonim Cave, explaining why these two sites are part of one cluster (Fig. 15). However, these sites are from two different environmental zones, as well as being located in different situations (open-air steppic, versus shelter Meditarranean forest). Thus, an explanation of this association must be one that does not rely on site location. This will be discussed below.

Nongeometiric microliths are relatively abundant in all of the Hayonim Terrace, Ain Mallaha, and Nahal Oren levels. Factor 2 consists, in part, of a positive association with nongeometric microliths. In the cluster diagram (Fig. 15), these three open-air sites from the Mediterranean forest form a cluster.

The Factor 3 association of notch/denticulates and borer/perforators is exemplified by the sites of Tell Abu Hureyra, Dibsi Faraj East, J2 and 406a in southern Jordan, 14/7 in the Black Desert, Rosh Zin and Rosh Horesha.

The sites that are associated with Factor 3 are the open-air steppic area sites that form a cluster in Figure 15. Numerous notch/denticulates also occur at Beidha in southern Jordan (B. Byrd, personal communication 1984). This suggests that when tool counts are available from Beidha, it may also cluster with the steppic sites.

None of the factor associations with eigenvalues over 1.0 help explain the clustering of Mugharet el-Wad, Mugharet el-Kebarah and Shukbah. However, an explanation of the tool classes in Table 12 shows that these sites are characterized by high percntages of geometric microliths. It may be suggested that this forms the basis of the close association of these shelter sites from the Mediterranean forest.

The principal components analysis suggests that the clusters formed during the cluster analysis were partially determined by the relatively high percentages of certain tool classes in each cluster. This may correlate with different types of activities in different environmental zones or in different areas of particular sites.

Within the environmental zone groupings, the tool classes represented by Factor 1 (scrapers and burins) and Factor 3 (notch/denticulates and borer/perforators) exemplify a chronological trend in chipped stone tool use at sites with more than one late Epipaleolithic level. Table 14 presents the percentage data used to plot these two factors in a scattergram (Fig. 16). At these sites, there is an increase through time in the percentage of notch/denticulates and borer/perforators, This occurs at el Khiam, Hayonim Terrace, Mugharet el-Wad, and Nahal Oren. The pattern is not as clear at Ain Mallaha, where notch/denticulates and borer/perforators increase from Levels III-IV to III, but decrease from III to Ib.

Table 14. Percentages and counts used for indicating chronological trends in certain tool classes
MW = Mugharet el-Wad,
NO = Nahal Oren,
AM = Ain Mallaha,
EK = el Khiam,
HT = Hayonim Terrace.

Site	Set 1	Set 2	Set 3	% Set 1	% Set 2	% Set 3
MW2	303	272	1193	17.14	15.38	67.48
MW1	162	160	453	20.90	20.65	58.45
NO6	57	68	199	17.59	20.99	61.42
NO5	72	140	163	19.20	37.33	43.47
AM3-4	126	107	240	26.64	22.62	50.74
AM3	110	137	152	27.57	34.34	38.10
AM1b	81	106	180	22.07	28.88	49.05
EK7	106	14	43	65.03	8.59	26.38
EK6	149	18	48	69.30	8.37	22.33
EK5	58	17	58	43.61	12.78	43.61
EK4	90	37	57	48.91	20.11	30.98
HTD	23	19	105	15.65	12.93	71.43
HTCL	25	30	119	14.37	17.24	68.39
HTCm	14	28	74	12.07	24.14	63.79
HTCu	33	56	106	16.92	28.72	54.36
HTB	9	22	32	14.29	34.92	50.79

Set Identification:
Set 1 = Scrapers and burins
Set 2 = Notches, denticulates, and borers
Set 3 = Non-geometric microliths

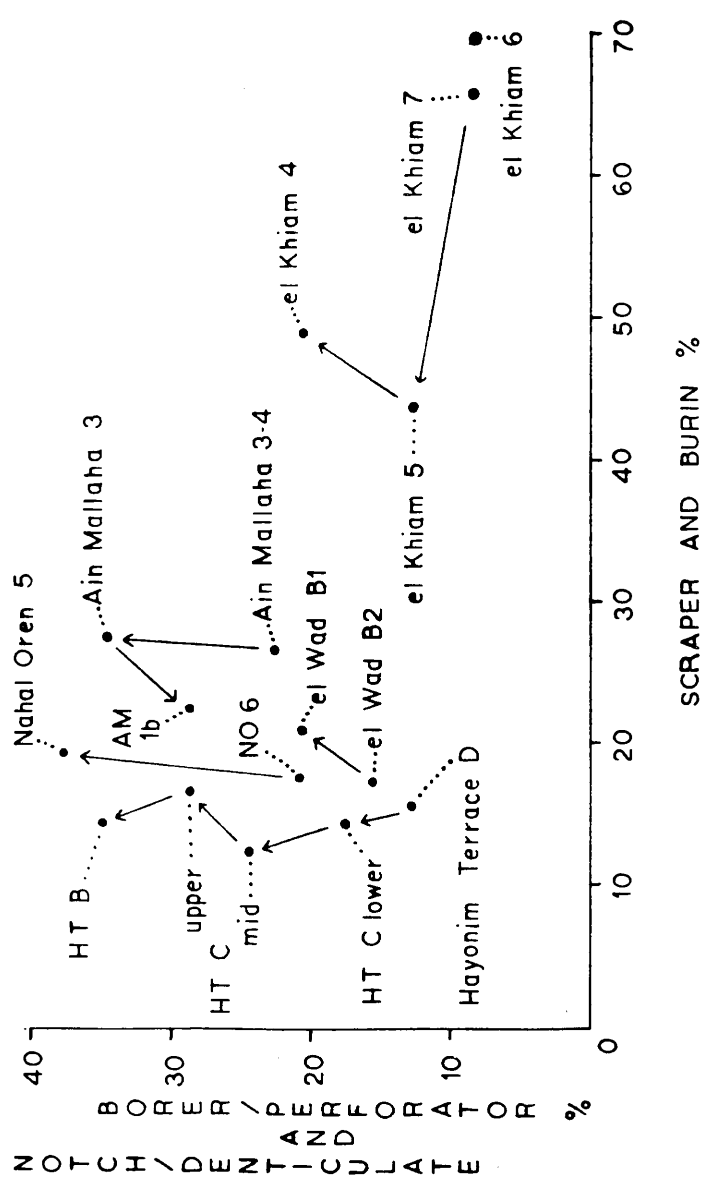


Figure 16. Scattergram of scraper and burin percentages against borer/perforator and notch/denticulate percentage for selected late Epipaleolithic sites.

Another chronological trend in chipped stone tool use is seen in the percentage data from Table 12. At sites with more than one late Epipaleolithic level (el-Wad, Nahal Oren, Ain Mallaha, Hayonim Terrace, el Khiam), there is an overall decrease in the percentage of nongeometric microliths, and an overall increase in the percentage of geometric microliths through time. This may be a continuation of the trend initiated earlier in the transition from the Kebaran to the Geometric Kebaran A, in which nongeometric microliths of various forms were replaced by geometric microliths.

The general tool classes of scrapers and burins, notch/denticulates and perforator/borers, relative to nongeometric microliths (the three factors isolated by the principal components analysis), apparently explain not only site situation within zones (open-air and shelter sites in the steppe and Mediterranean forest), but also show increase through time in the use of notch/denticulates and borer/perforators at sites with more than one late Epipaleolithic stratigraphic level. The other chronological trend is that of an apparent increase in geometric microliths through time.

Conclusions Regarding the Comparative Analyses

Comparative analyses using general tool classes for 18 to 27 sites and levels of sites indicate that there is some association between tool assemblages and chronlogical succession of levels of some sites, tool assemblages and environmental zones, as well as between tool assemblages and open versus shelter sites. These anlayses do not reflect, on the level of general tool classes, a separation of the north Syrian assemblages from those of the Natufian area.

Tool assemblages associated with the environmental zones of the steppe and the Mediterranean forest appear to be substantially different. Specifically, assemblages characterized by relatively higher percentages of notch/denticulates and borer/perforators are usually associated with open-air steppic environments.

On the other hand, the open-air Mediterranean forest sites (Ain Mallaha, Nahal Oren and the Hayonim Terrace) are characterized by relatively higher percentages of nongeometric microliths. Shelter Mediterranean forest sites (Mugharet el-Wad, Mugharet el-Kebarah and Shukbah) are characterized by relatively high percentages of geometric microliths. The presence of these two groups in the Mediterranean forest zone could reflect activity orientation, chronological evolution in tool types, stylistic preferences, or the effects of sample selection on the part of early excavators.

In contrast to the two environmental zone groups, and to site locations within these zones, relatively high percentages of scrapers and burins appear at el Khiam and

Hayonim Cave. Since these two sites are in different environmental zones, and in different situations (open-air versus shelter), and since they do not show a similarity with the tool assemblages from sites in their respective environmental zones, it appears that they may represent specific activity loci related to larger site areas. For example. the occupation of Hayonim Cave may be a specialized task area related to the occupation of the Hayonim Terrace.

A comparison of the tool classes other than those tools that are part of the factors that characterize each group from sites in the steppic area and the Hayonim Cave-el Khiam association (Table 15) shows that the presence of other tool classes varies greatly from site to site. This is in contrast to the Mediterranean forest groupings (Table 16), where overall tool assemblages are very similar.

An examination of the relationship between scrapers and burins, and notch/denticulates and borer/perforators, yields an interesting chronological trend. Sites with more than one late Epipaleolithic stratigraphic level (el-Wad, Nahal Oren, el-Khiam, Hayonim Terrace, Ani Mallaha) show an increase through time in the percentage of notch/denticulates and borer/perforators. These sites also document an increase in the relative frequency of geometric microliths compared to nongeometric microliths through time.

The use of general tool classes in the preceding analyses shows that all of the sites used in the sample, including the north Syrian sites, share affinities with each other. This is confirmation of the fact that the prehistoric occupations at these Levantine sites are reflections of generalized late Epipaleolithic patterns of chipped stone tool use in the Levant. However, this type of analysis leaves open the question of whether or not the industries from northern Syria are distinct from those of the Natufian area.

Chipped Stone Industries During the Levantine Late Epipaleolithic

To be able to adequately assess the question of whether or not the presently defined Natufian complex describes all of the industries present in the Levant during the late Epipaleolithic, it is necessary to compare the relative abundance of particular tool types from late Epipaleolithic assemblages and the technological processes underlying the production of those tool types. However, as has been discussed, published accounts of tool assemblages do not consistently provide this information. Therefore, at the moment, only an assessment of specific details that compares the Tell Abu Hureyra, Dibsi Faraj East and Tell Mureybat materials with a generalized Natufian assemblage is possible.

Henry (1981:422-423) provides a definition of the common

Table 15. Percentages of tool classes grouped by cluster groups of steppe and of Hayonim Cave-el Khiam associations.

Site	Scraper	Borer/Perf	Burin	Geometric	Nongeomet.	Notch/Dent
Tell Abu Hureyra (N=1731)	23.5	7.8	8.7	18.5	13.8	27.7
Dibsi Faraj East (N=72)	20.8	9.7	5.6	41.7	2.8	19.4
Rosh Horesha (N=2195)	3.9	2.1	17.9	43.8	8.7	23.6
Rosh Zin (N=933)	9.5	2.6	13.7	49.1	5.6	19.5
Black Desert 14/7 (N=142)	9.2	14.1	4.2	13.4	16.2	42.9
J2, southern Jordan (N=58)	5.2	0.0	1.7	41.4	10.3	41.4
406a, southern Jordan (N=44)	2.3	6.8	0.0	54.5	15.9	20.5
el Khiam 7 (N=195)	20.5	5.1	33.8	16.4	22.0	2.1
el Khiam 6 (N=262)	19.5	3.8	37.4	17.9	18.3	3.1
el Khiam 5 (N=173)	15.6	5.2	17.9	23.1	33.5	4.6
el Khiam 4 (N=230)	21.3	10.9	17.8	20.0	24.8	5.2
Hayonim Cave interior (N=238)	24.8	0.0	36.1	13.0	5.5	20.6
Hayonim Cave exterior (N=166)	24.7	0.0	49.4	3.0	8.4	14.5

Table 16. Percentages of Tool Classes grouped by cluster groups in the Mediterranean forest groups.

Site	Scraper	Borer/Perf	Burin	Geometric	Nongeomet	Notch/Dent
Mugharet el-Wad B2 (N=6818)	1.9	3.5	2.5	74.1	17.5	0.5
Mugharet el-Wad B1 (N=3575)	1.1	3.3	3.4	78.3	12.7	1.2
Mugharet el-Kebarah (N=100)	5.0	3.0	4.0	83.0	5.0	0.0
Shukbah (N=557)	6.8	6.1	6.3	65.7	14.2	0.9
Nahal Oren 6 (N=441)	2.5	2.7	10.4	26.5	45.1	12.7
Nahal Oren 5 (N=532)	2.1	3.0	11.5	29.5	30.6	23.3
Ain Mallaha III-IV (N=531)	3.8	4.9	19.9	10.9	45.2	15.3
Ain Mallaha III (N=454)	6.2	5.5	20.3	9.9	33.4	24.7
Ain Mallaha Ib (N=445)	2.9	3.8	15.3	17.5	40.4	20.0
Hayonim Terrace D (N=171)	9.9	1.2	3.5	14.0	61.4	9.9
Hayonim Terrace C lower (N=202)	6.9	1.5	4.5	15.8	58.9	12.4
Hayonim Terrace C middle (N=149)	6.7	0.7	2.7	22.1	49.7	18.1
Hayonim Terrace C upper (N=239)	7.5	1.3	6.3	18.4	44.3	22.6
Hayonim Terrace B (N=81)	9.9	3.7	1.2	22.2	39.5	23.5

features of Natufian asemblages, and indicates which specific tool types within the various tool classes are most characteristic. To summarize, Henry states that Natufian chipped stone assemblages are characterized by microlithic technology, with a predominance of lunates, the production of broad bladelets from multiplatform cores, and the consistent use of the microburin technique (although it is noted that microburin technique decreases in frequency from south to north). Among the tool classes, the following features are noted. Scrapers are usually simple end scrapers on blades. Characteristic burin forms are single blow truncation varieties and those on snaps. Straight backed blades and bladelets are the most common backed pieces. Single notches are common. Denticulates are more frequently manufactured on blades than on flakes. Sickle blades are usually on blades rather than bladelets. Finally, massive pieces are most commonly scrapers, notches, lames à machure, and denticulates.

Several of the features described in Henry's definition are also characteristic of the north Syrian assemblages. These include the use of microlithic technology, the dominance of the lunate in the geometric microlith class, and the abundance of single notches. In addition, backed bladelets in north Syrian assemblages are usually the staight backed variety.

However, the differences between the north Syrian and Natufian assemblages suggest that a distinct development of late Epipaleolithic industries occurred along the Euphrates River. The production of broad bladelets from multiplatform cores is not a feature shown by the majority of north Syrian core types (Appendix A). Multiplatform cores (polyhedral) are the domiinant core type at both Tell Abu Hureyra and Dibsi Faraj East. However, these are cores for the production of flakes rather than for bladelets.

A second major difference can be found in the comparison of the blank type used in the manufacture of scrapers and denticulates. While Henry states that these are blade blanks in the Natufian assemblages, scrapers from Tell Abu Hureyra and Dibsi Faraj East are characteristically made on flake blanks (97.3% at Tell Abu Hureyra and 80% at Dibsi Faraj East). Natufian denticulates are also made on blades. The Tell Abu Hureyra denticulates are predominantly on flakes (88% of denticulates), although the two Dibsi Faraj East denticulates are both on blade/bladelet blanks.

Sickle blades are rare or absent in north Syrian assemblages dating to the late Epipaleolithic. This contrasts with the Natufian where many sites have at least a few examples of this tool type (Mugharet el-Wad, Hayonim Cave, Shukbah, Rosh Horesha, Ain Mallaha, Nahal Oren, el-Khiam, and Mugharet el-Kebarah).

In addition, north Syrian burins are usually on natural edges, on striking platforms, on breaks or are dihedral forms. The backed pieces class in north Syria is dominated by backed flakes.

Finally, massive pieces (or heavy tools) in the Tell Abu Hureyra assemblage are predominantly the types of gouges, axes, and blunted implements (Appendix B, Figs. B-19 to B-27). The erminette from Tell Mureybat is probably a later, more sophisticated version of the gouge type found at Tell Abu Hureyra. Heavy tools were not recovered from the Dibsi Faraj East surface collection. In contrast, gouges, axes, and blunted implements are rarely reported from Natufian sites.

The tendency for lunates to become smaller through time has been demonstrated by various studies in the Natufian area (Bar-Yosef and Valla 1979; Valla 1981), and also seems to occur in northern Syria, with long lunates, averaging 26 mm. at Tell Abu Hureyra and short lunates, averaging 15 mm. at Tell Mureybat. The radiocarbon dates range from 9,200 b.c. for Tell Abu Hureyra to 8,250 B.C. or earlier for Tell Mureybat. The presence of Helwan retouch in Natufian assemblages has long been thought to be a chronological indicator for the early phase of the Natufian (Garrod and Bate 1937; Neuville 1951; Perrot 1966; M.-C. Cauvin 1966; Bar Yosef and Tchernov 1966; Henry 1977; Bar-Yosef and Valla 1979). Recent work in the el-Kowm area of northern Syria has suggested that, on the basis of present evidence, Helwan retouch may also serve as an early marker for the northern Syrian assemblages (M.-C. Cauvin 1981a). However, it should be noted that Helwan retouch in northern Syria appears to be a minimally used technique.

The orientation of the Tell Abu Hureyra assemblage toward the production of flakes and flake tools, such as scrapers, and toward the incorporation of heavy tools, such as the gouge, suggest that inhabitants of this region either practiced activities not found in the Natufian area, or performed similar activities using different techniques and technology. For these reasons, the northern Syrian industries should not be called Natufian, but should reflect their separate status. For the moment, it is proposed that the industries from northern Syria be called the north Syrian late Epipaleolithic.

Thus, while many similarities exist between the Natufian and the north Syrian assemblages in the tool classes employed by these groups, these similarities are perhaps more indicative of the range of activities carried out by hunting and gathering groups, than they are of a pan-Levantine Natufian cultural unity. Instead, the basic technology underlying these complexes can be seen to be fundamentally different, perhaps reflecting different groups or activity orientation in the Levant during the late Epipaleolithic.

Summary

The chipped stone from the lower half of the late Epipaleolithic component (levels 280-330) at Tell Abu Hureyra was classified and analyzed. The typology employed is based on that formulated by Tixier (1963) for the Maghreb of northern Africa. Although many of the tool types specific to Tixier's typology are not applicable to the Levantine late Epipaleolithic, Tixier's typology provides a reasonable basic outline for classification. The use of this typology for the Levantine late Epipaleolithic by Bar-Yosef (1970a) and Hours (1974), in fact, makes it essential for comparative studies. A few of the types used by Bar-Yosef were also used in the study of the Tell Abu Hureyra materials. These include the distinction between perforator and borer. The Hours' typology was oriented in its microlithic categories to combinations of form and retouch style. Since the Tell Abu Hureyra materials are almost exclusively backed by abrupt and only occasionally by anvil retouch, the approach by Hours was not employed in the Tell Abu Hureyra analysis.

The advent of microwear analyses has added a much needed dimension to formal typology and classification. Microwear analyses allow the interpretation of the function of tools. However, this approach is largely tool specific. Apparently, many of the tool classes, such as notches and denticulates, and burins, were multipurpose tools, where the same form could be used for a variety of different tasks on a variety of materials. Recent microwear analysis of a small sample of lunates and "lustred" blades from Tell Abu Hureyra and Tell Mureybat, shows that the lunates examined were primarily used as arrow barbs or tips. The "lustred" blades had been used to cut rushes and sedges.

The Tell Abu Hureyra late Epipaleolithic chipped stone industry is characterized by the predominance of three classes of tools. These are notches and denticulates, scrapers, and microliths. Geometric microliths are more common than nongeometrics, and are dominated by lunates with abrupt retouch. Some lunates have anvil retouch. The scraper class is dominated by scrapers on flakes, where the flake blank has some cortex present. Perforators and borers form a small percentage of the assemblage, as do burins. Retouched pieces, perhaps representing ad-hoc or lightly-used tools, are also well represented. Heavy tools consist mainly of three types of implements; gouges, representing perhaps the forerunner of the <u>erminette</u> found at Tell Mureybat, axes, and blunted implements. The Various category is dominated by sidescrapers. The majority of cores are single platform or polyhedral varieties for the production of flakes.

Other north Syrian sites, Dibsi Faraj East, Tell Mureybat, and the el-Kowm area, show many similarities to the assemblage from Tell Abu Hureyra. However, the full interpretation of these other assemblages is limited by the

lack of published information and the nature of recovery from surface collections and test pits. Material from all of these northern Syrian sites suggests that the northern Syrian assemblages share a close affinity.

Quantitative analyses using distance coefficients, cluster analysis, and principal components analysis, show that all of the Levantine late Epipaleolithic chipped stone assemblages including the north Syrian sites share similar patterns of chipped stone tool use when general tool classes are used as the data base. Preliminary results indicate that open-air sites in steppic environments (Tell Abu Hureyra, Dibsi Faraj East, Black Desert 14/7, Rosh Horesha, Rosh Zin, and J2 and 406a in southern Jordan) are characterized by relatively higher percentages of notch/denticulates and borer/perforators. Two groups of Mediterranean forest assemblages occur. The open-air sites in this zone (Ain Mallaha, Nahal Oren and the Hayonim Terrace) have relatively high frequencies of nongeometric microliths. The shelter sites, on the other hand (Mugharet el-Wad, Mugharet el-Kebarah and Shukbah) have relatively high percentages of geometric microliths. These differences may be the result of activity-orientation, chronological trends or stylistic preferences. A final grouping of sites with relatively high percentages of scrapers and burins (el Khiam and Hayonim Cave) may relate to activity orientation that is independent of environmental zone .

In addition to clusters related to environmental zones and activity-orientation, the tool classes of scrapers and burins, and notch/denticulates and borer/perforators also provide insight into a chronological trend in late Epipaleolithic chipped stone tool use. There is an increase in the relative frequency through time of notch-denticulates and borer/perforators. This suggests that activities associated with these tool classes became increasingly important through time in the Levant.

The percentage of geometric microliths in assemblages with more than one late Epipaleolithic level also appears to increase through time, while the percentage of nongeometric microliths decreases. One explanation for this trend may be that it reflects a continuation of the pattern initiated in the transition from the nongeometric microliths of the Kebaran to the geometric microliths of the Geometric Kebaran A.

When the data base is expanded to include tool class subtypes, types of blanks used for tools, and core morphology, a distinction between Natufian and north Syrian assemblages emerges. In the Natufian complex, heavy tools consist of picks, massive scrapers, massive notches, and massive denticulates In north Syria, heavy tools are gouges, axes, and blunted implements. Sickle blades are rare in north Syria, and have a variable distribution in the Natufian. Helwan retouch a hallmark of the early period of the Natufian, is only found in small amounts in the el-Kowm area in what is perhaps a very early context. A fundamental difference between north Syria and the Natufian area lies in the technology of blank production. Natufian assemblages were geared toward the production of short, wide bladelets from pyramidal and multiplatform cores. The north Syrian technology concentrated on the manufacture of flakes from either single platform or polyhedral (multiplatform) cores. Thus, each of the two regions shows a distinct and internally consistent technological and typological pattern. This suggests important underlying cultural differences that merit the separation of the late Epipaleolithic assemblages from sites bordering the Euphrates in northen Syria as a north Syrian late Epipaleolithic industry, distinct from the Natufian and Natufian-like industries found in the central and southern Levant.

CHAPTER 6

LUNATES

The microlithic element, the lunate, has been recognized by researchers, such as Garrod (1932a), Neuville (1951), Bar-Yosef (1970a), Henry 1973b) Bar-Yosef and Valla (1979) and Valla (1981), as one of the hallmark characteristics of the Levantine late Epipaleolithic. It has been defined by Tixier (1963:129) as a "Microlithe géométrique ayant la silhouette d'un segment de cercle ou d`un demi-cercle. L`arc est obtenu par des retouches abruptes, la corde est une portion de tranchant brut rectiligne."

Because it is a component of all Levantine late Epipaleolithic assemblages, there have been various attempts over the years to determine if lunate attributes vary over time and space. The first of these was Garrod`s (1932b:261) observation that the lower level (B2) at Mugharet el-Wad contained lunates exhibiting backing formed by bifacial, or Helwan, retouch. This was in contrast to the Layer B1 lunates that showed a predominance of abrupt backing. Therefore, late Epipaleolithic sites could be said to be Lower or Upper Natufian, based on the predominant type of retouch exhibited by the lunates.

The advent of radiocarbon dating allowed better chronological control for study of lunate attribute variability. The length of lunates has been found to decrease through time (Bar-Yosef and Valla 1979:146; Valla 1981:97, Table 7). Recently, Valla (1981:97, Table 7 has proposed a tripartite division of the Natufian based on lunate length and the frequency of Helwan retouch. This is shown in Table 17. As can be seen from this data, a considerable amount of overlap exists between the Early and Late Natufian. In fact, if one used only length of lunates as a criterion for the temporal placement of Natufian sites, then all Late Natufian sites except Ain Mallaha Ic, Hayonim Cave upper B, Mugharet el-Wad B-1, Rosh Zin, and Nahal Oren VI, should be classified as Early Natufian. In this context, Mureybat Ia, with a mean length of 15 mm., would be more appropriately placed within the Late Natufian.

A statistical comparison between the three Natufian phases proposed by Valla shows that average lunate lengths characterizing each phase do differ significantly at the .95 level. Since Valla's report does not include standard deviations for each of the lunate populations he sampled, a mean of the means given by Valla was calculated for each phase. For the comparison of Early Natufian and Late Natufian, with 15 degrees of freedom, and a .95 level of significance, the t-value is 1.753. The calculation of the differences between the means of the Early Natufian (23.12mm.) and Late Natufian (18.63 mm.) results in a value of 2.33. Thus, the lunate length means between Valla's

Table 17. Valla's phase sequence for the Natufian.

Site	N	Lunate Mean Length	% Helwan Retouch	Age in B.C.
Early Natufian				
Beidha	71	28.28 mm	83.09	-
Erq el Ahmar A2	162	27.00 mm	51.85	-
Oumm Qala'a	91	21.74 mm	72.52	-
Kebarah B	85	23.40 mm	64.70	9,200 ± 400
el-Wad B2	360	19.46 mm	47.22	9,970 ± 660 9,525 ± 600
Hayonim Cave B lower	19	19.73 mm	94.73	
Ain Mallaha IV (III-II)	64	22.28 mm	59.40	9,360 ± 880 9,790 ± 570 9,640 ± 540
Late Natufian				
Rosh Horesha	103-142	22.86-19.76 mm	0.0	8,540 ± 430 8,930 ± 280
Rosh Zin	?	18.00 mm	less than 1.0	-
Oumm ez-Zoueitina	21	20.50 mm	14.28	-
Tor Abu Sif	131	19.00 mm	6.87	-
Salibiyah I	66	20.00 mm	1.51	-
Shukbah B	45	20.15 mm	0.0	-
el-Wad B1	106	14.96 mm	10.37	7,845 ± 600
Nahal Oren VI	27	15.59 mm	0.0	-
Hayonim Cave B upper	38	17.81 mm	36.84	-
Ain Mallaha Ic	30	17.50 mm	46.29	-
Final Natufian				
Fazael IV	85	13.07 mm	0.0	-
Nahal Oren V	35	13.20 mm	0.0	-
Ain Mallaha Ib	69	13.47 mm	18.49	-
Tell Mureybat Ia	?	15.00 mm	?	ca.8,250 ± 150

After Valla 1981:97.

Early and Late Natufian assemblages differ significantly.

Similarly, the mean calculated from the means given by Valla for the Late (18.63 mm.) and Final (13.68 mm.) Natufian lunate assemblages also differ significantly at the .95 level. In this case, the t-value is 1.782 with 12 degrees of freedom at the .95 level. The value calculated comparing Late and Final Natufian assemblages is 2.3. This exceeds the t-value and indicates that these lunate populations differ significantly. However, as will be discussed below, Valla's phase delineation, treated in this manner, may be masking variability in lunate length between Natufian assemblages from the steppe and from the forest/coast zones.

Available radiocarbon dates are incorporated into Table 17. While these suggest a temporal trend in average lunate length decrease, it is apparent that these dates are few in number, especially for the Late and Final Natufian phases. Accepting the available chronological evidence, length alone does not appear to be a completely reliable guide for the temporal placement of late Epipaleolithic sites. The incidence of Helwan retouch has also been used by Valla (1981:97, Table 7) to refine his three-fold division. In general, sites with longer lunates and greater than 50% Helwan retouch are seen as early Natufian. Sites with less than 50% Helwan retouch and somewhat smaller lunates are classified as Late Natufian. Final Natufian is considered to have very small lunates and should have no Helwan retouch.

There are two exceptions in Valla's scheme. Mugharet el-Wad B2, classified as Early Natufian, has less than 50% Helwan retouch, although having somewhat long lunates, at 19.46 mm. Radiocarbon dates, on bone, from Mugharet el-Wad B2 have yielded dates of 9,970 $\pm$ 660 b.c. (UCLA) and 9,525 $\pm$ 600 b.c. (UCLA) (Bar-Yosef and Valla 1979:148). These dates suggest that the Natufian from Mugharet el-Wad B2 may be from an early context. However, these dates should be viewed with caution since they were made on materials from excavations conducted over 50 years ago, and dates on bone are subject to many kinds of distortion. In addition, Ain Mallaha Ib, classified as Final Natufian, has over 18% Helwan retouched lunates, yet manifests very small lunates. This suggests several possibilities.

On the one hand, Ain Mallaha III has a radiocarbon date of 9,360 + 880 b.c. (Ly-1662) (Evin et al. 1979:442-443). Therefore, Ain Mallaha Ib probably dates later than this. However, whether Ain Mallaha Ib is post-9000 b.c., when Helwan style retouch presumably was no longer used, is unknown. If Ain Mallaha Ib predates 9,000 b.c., this might explain the presence of Helwan retouched lunates, although not the extreme small size of the lunates. Alternatively, if there is any possibility that a portion of the sample from Ain Mallaha Ib is derived from lower levels, this also could account for the presence of Helwan retouch, but not for the shortness of the lunates.

One final observation can be made regarding the published data given by Valla (1981). If one separates the Natufian lunate assemblages into steppe and forest/coast zones for each of Valla's Natufian phases a dichotomy in lunate length between the steppe and the forest/coast sites within each temporal phase given by Valla is suggested. Thus, for each phase of the Natufian, lunates from forest/coast zone tend to be shorter on the average than those from the steppic sites (with the exception of Oumm Qala's and Shukbah. Although site sample size is small, this trend is absent by the Final Natufian (excluding Tell Mureybat Ia., which is not a Palestinian site) Fig. 17). The metric overlap of the lunate assemblages from Oumm Qala'a (steppe) with forest/coast zone lunate assemblages, and that of the lunate from Shukbah (forest/coast) with steppic lunate assemblages may perhaps be explained by the fact that lunate length is a continuous variable. Thus, one might anticipate that steppic lunate assemblages from late in each time phase would exhibit some metric overlap with forest/coast lunate assemblages from early in each time phase.

Tell Abu Hureyra and Museum Collections

The recent work by Bar-Yosef and Valla (1979) and Valla (1981), on chronological trends shown by Natufian lunates, suggested that the complete lunates from Tell Abu Hureyra (1) could be treated in a similar manner. In addition to this northern Syrian sample, several other collections of lunates from the Natufian and northern Syrian areas were examined. These include Rosh Horesha, (2) Rosh Zin, (2) Mugharet el-Wad, (3) Nahal Oren, (4) Mugharet el-Kebarah, (4) and Dibsi Fasraj East, (5). Table 18 shows the sample size of complete lunates from each site.

A variety of metric observations was recorded for each lunate. These include length, width at midpoint, width at widest point, maximum length to widest point, thickness, and the nonmetric attribute of retouch type (Fig. 18). Length was defined as the measurement from pointed tip to pointed tip of the lunate. This coincided with the length of the straight untouched edge. Width at midpoint was the measurement taken perpendicular to the length midway between the lunate tips. Width at the widest point was taken perpendicular to the unretouched edge at the greatest

(1) Collections from Andrew Moore, parts of which are designated to be sent to the British Museum, London, the Oriental Institute, Chicago, and the Royal Ontario Museum,Toronto. Trench and sieve samples from Trench E Levels 252-279 are in the National Museum, Aleppo.
(2) Collections at Southern Methodist University, Dallas.
(3) Collections at the British Museum, London, and the Museum of Anthropology and Archaeology, Cambridge.
(4) Collection at the British Museum, London.
(5) Collection at the Ashmolean Museum, Oxford.

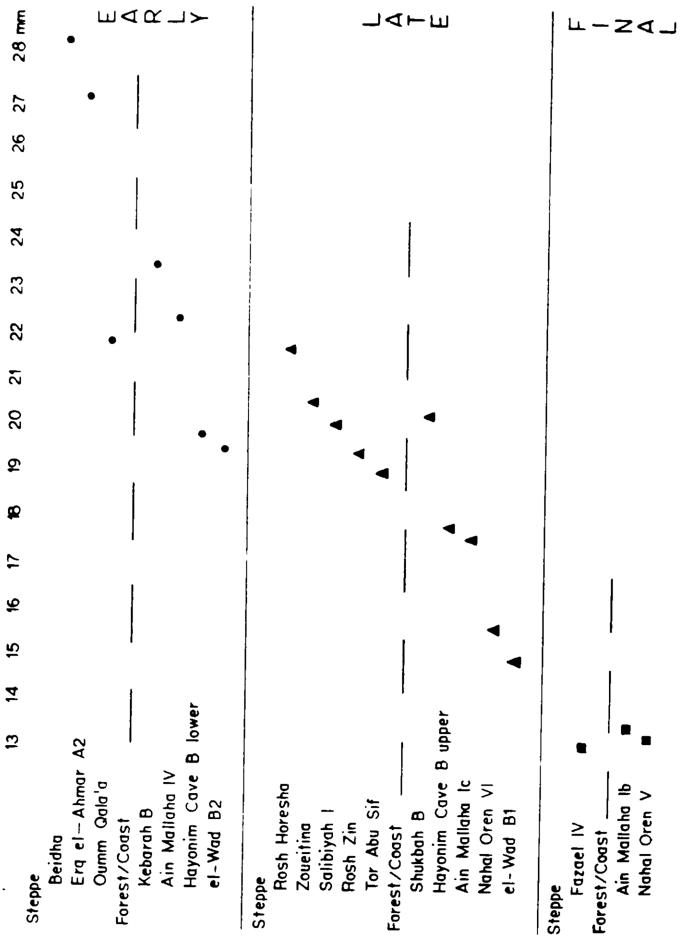


Figure 17. Mean lunate length plotted by temporal phase and enviornmental association for Natufian assemblages.

Table 18. Retouch type frequency at selected late Epipaleolithic sites.

Site	Retouch Type											
	Abrupt		Inverse Abrupt		Inverse Semi-steep		Anvil		Fine		Helwan	
	#	%	#	%	#	%	#	%	#	%	#	%
Tell Abu Hureyra (219)	166	75.7	6	2.8	-	-	41	18.8	6	2.8	-	-
Dibsi Faraj East (13)	9	69.2	3	23.1	-	-	1	7.7	-	-	-	-
Rosh Horesha (101)	61	60.4	7	6.9	-	-	33	32.7	-	-	-	-
Rosh Zin (101)	77	76.2	3	21.0	-	-	19	18.8	-	-	2	2.0
Mugharet el-Kebarah (47)	6	12.8	1	2.1	1	2.1	6	12.8	-	-	33	70.2
Mugharet el-Wad B2 (201)	70	34.8	5	2.5	1	0.5	46	22.9	-	-	79	39.3
Nahal Oren (99)	44	44.4	-	-	-	-	54	54.5	-	-	1	1.0

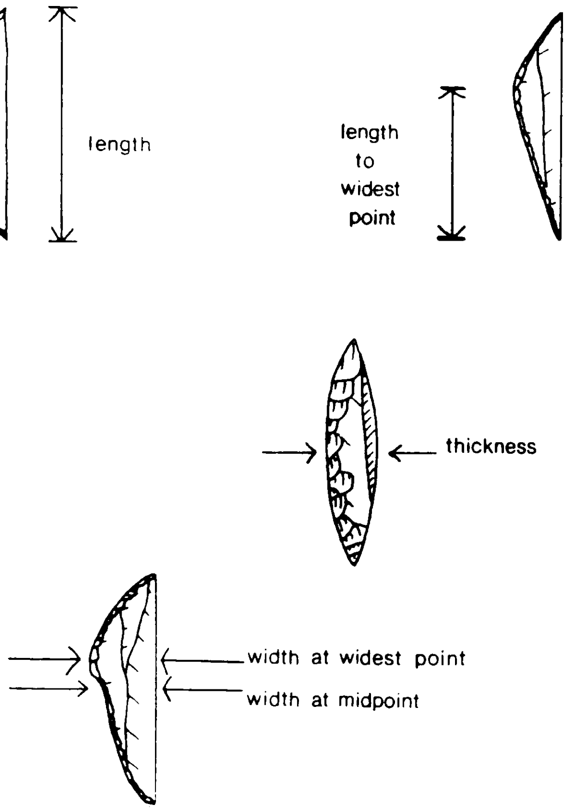


Figure 18. Illustration showing how metric measurements were taken for lunate attributes.

outward projection of the backed edge. Length to the widest point was measured from one pointed tip of the lunate along the unretouched edge to a spot opposite the widest projection of the backed edge. Maximum thickness was taken at the midpoint of the lunate, along the backed edge. All measurements were recorded to the nearest one-hundredth of a millimeter using metric scale calipers. The raw data for all observations is presented in Appendix E.

Retouch type was divided into the following categories: direct abrupt, inverse abrupt, inverse semi-steep, anvil, fine, and Helwan. These are defined in Appendix B. The frequency of each type of retouch on lunates is presented in Table 18.

Histograms for each site except Dibsi Faraj East (Fig. 19) provide a graphic display of the length variable. The mean, median, standard deviation, smallest value, largest value, and range for each site are presented in Table 19. The longest lunates are those from the northern Syrian sites of Tell Abu Hureyra (and Dibsi Faraj East). Rosh Horesha and Mugharet el-Kebarah average over 20 mm., while Rosh Zin and Mugharet el-Wad are less than 20 mm. Nahal Oren produced the smallest lunates, averaging just under 16 mm. A comparison of the means of each sample population with the medians (Table 19) shows that these do not greatly differ. Medians are larger than means by 0.1 to 0.7 mm. for Tell Abu Hureyra, Rosh Horesha, Rosh Zin, and Nahal Oren. The medians are smaller by 0.2 to 1.2 mm. for Dibsi Faraj East, Mugharet el-Wad and Mugharet el-Kebarah.

The sample from Mugharet el-Wad exhibits a skewed distribution. This may suggest that sample selection is responsible for the lack of lengths representing the lower tail of the distribution. The histograms from Tell Abu Hureyra and Nahal Oren, when compared with the histogram from Mugharet el-Wad, show that lunates smaller than 12 mm. and larger than 32 mm. do occur. The lack of small lunates from Mugharet el-Wad may be a factor of the excavation and recovery techniques utilized by Garrod. The extremely small sample (N = 13) from Dibsi Faraj East is too small to be significant statistically.

A comparison between the means of length measurements obtained in this study and those given by Valla (1981:97, Table 7) shows some agreement and some discrepancy. Valla's Early Natufian sites (Table 17) of Mugharet el-Kebarah B (23.40 mm.) and Mugharet el-Wad B2 (19.46 mm.) are similar to the average lengths obtained in this study of 23.57 mm. and 19.82 mm., respectively (Table 19). For the Late Natufian period, this study produced similar results for Rosh Horesha, but a higher length average for Rosh Zin (19.46 mm. compared to Valla's 18.00 mm.). Finally, a breakdown of the Nahal Oren materials in this study (Table 20) produced identical results for levels VI and V, whereas Valla's measurements (Table 17) indicate a difference between these levels. It is not possible to assess the

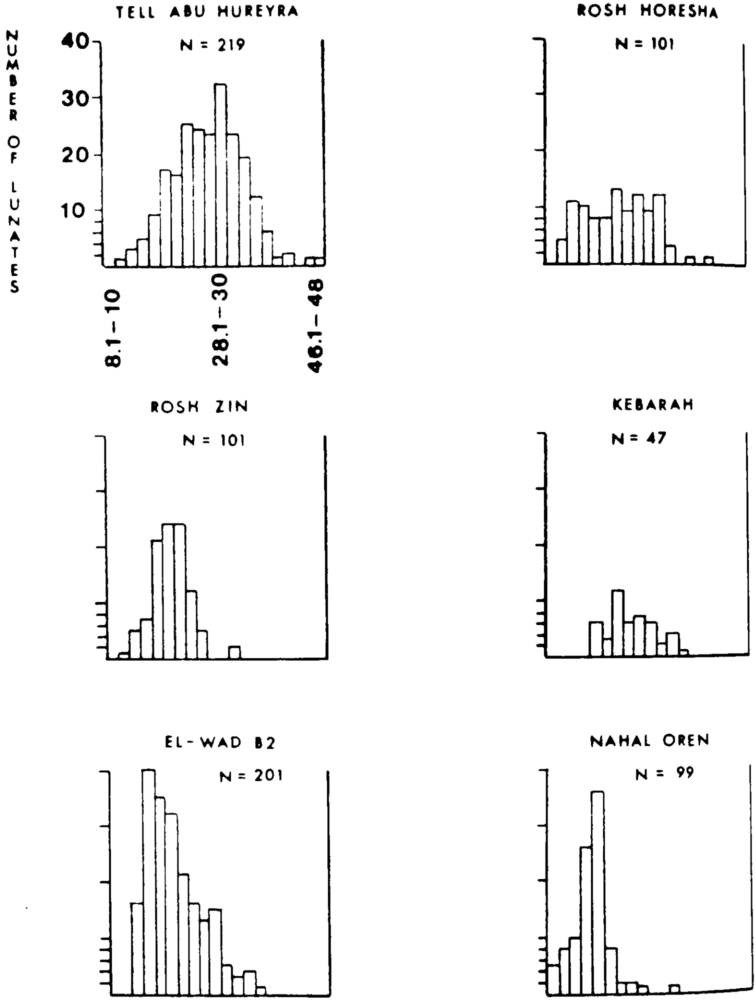


Figure 19. Histrograms for length of lunates from selected late Epipaleolithic sites (in mm.).

Table 19. Metric information on lunate length from selected late Epipaleolithic sites.

Site	Mean	Median	Standard Deviation	Smallest Value	Largest Value	Range
Tell Abu Hureyra	26.7 mm	27.4 mm	$\pm$ 6.1	10.8 mm	48.0 mm	39.05 mm
Dibsi Faraj East	30.3 mm	29.5 mm	$\pm$ 5.0	23.55 mm	40.25 mm	16.7 mm
Rosh Horesha	21.6 mm	21.8 mm	$\pm$ 6.0	11.1 mm	38.2 mm	27.1 mm
Rosh Zin	19.4 mm	19.5 mm	$\pm$ 3.3	11.5 mm	30.9 mm	19.4 mm
Mugharet el-Kebarah	23.5 mm	23.3 mm	$\pm$ 4.1	17.2 mm	33.45 mm	16.25 mm
Mugharet el-Wad B2	19.8 mm	18.6 mm	$\pm$ 4.9	13.0 mm	36.1 mm	23.1 mm
Nahal Oren	15.8 mm	16.1 mm	$\pm$ 3.2	8.95 mm	30.35 mm	21.4 mm

Table 20. Mean Lunate length by level for the Nahal Oren sample in England.

Level	Nahal Oren Mean Lunate Length	
38	Natufian	18.5 mm
34	V	15.5 mm
15	VI	15.8 mm
8	VI-VII	15.4 mm
4	7-1	16.6 mm

since statistical significance of this difference since Valla does not provide data other than mean length and sample size. The difference between the two studies of Nahal Oren materials is especially interesting since almost identical sample sizes, but from different museum collections, were measured for Nahal Oren V. This suggests that the nature of the samples at various museums and institutions may vary significantly, and that studies should attempt to utilize collections from as many sources as possible in order to obtain a more balanced picture.

The second variable displayed in histograms for each site is that of the width at the midpoint (Fig. 20). This variable was chosen over that of the width at the widest point, because it was felt that the width at the midpoint was a more accurate reflection of the size of the lunate, based on the results of a principal components analysis (discussed below). As with the length variable, the mean, standard deviation, smallest and largest values, and range are given for each site (Table 21). Again, there is some discrepancy in the normality of the distribution for several sites. These include Rosh Horesha, Mugharet el-Wad, and Nahal Oren. It is the smallest interval, up to 3 mm., that is lacking for both Mugharet el-Wad and Nahal Oren. This may be a relfection of a lower limit to the width dimension, perhaps with a technological or functional reason for the inappropriateness of lunates with widths less than 3 mm. The sample from Dibsi Faraj East is too small to assess accurately.

Thickness, the third size variable is displayed for each site (Fig. 21). The mean, standard deviation, range, and smallest and largest values are presented in Table 22. The relative lack of lunates exhibiting a thickness of less than 1.3 mm. suggests that this may be a lower practical limit for thickness.

The comparison of the means for each of these three variables, length, width at the midpoint, and thickness, for each site, suggests that longer lunates tend to be absolutely wider and thicker, while shorter lunates are narrower, and thinner (Table 23). In a sense, this implies that the overall shape, determined by length, width at the midpoint, and thickness, is the same from site to site, and therefore, between time phases of the late Epipaleolithic (Fig. 22). The absolutely thicker means for Tell Abu Hureyra and Dibsi Faraj East may indicate that some lunates here were fashioned from flake blanks.

If longer lunates tend to be wider and thicker, it may be that these dimensions are correlated. Figure 23 presents a scattergram of length plotted against midpoint width. The correlation is .76. Closer inspection reveals that longer lunates have an apparently greater range of width values. Scattergrams plotting length against thickness (Fig. 24), and thickness against midpoint width (Fig. 25), reveal even less correlation between these variables. However, there is

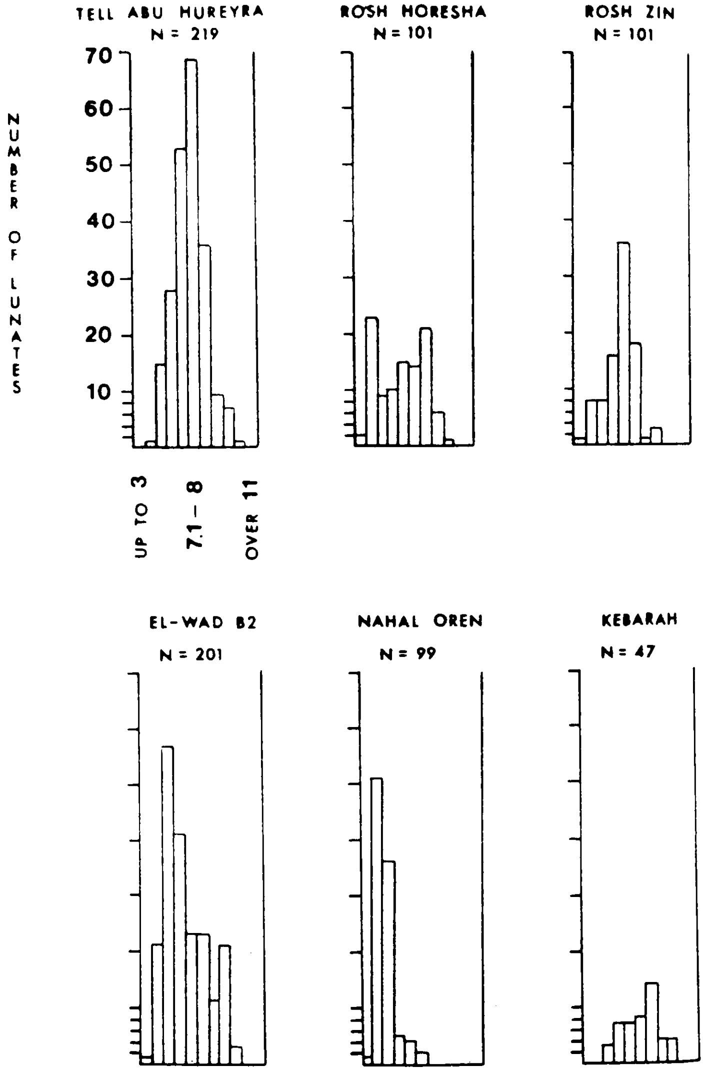


Figure 20. Histograms for width at midpoint of lunates from selected late Epipaleolithic sites (in mm.).

Table 21. Metric information on lunate width at midpoint for selected late Epipaleolithic sites.

Site	Mean	Standard Deviation	Smallest Value	Largest Value	Range
Tell Abu Hureyra	7.1 mm	1.3 mm	3.8 mm	11.4 mm	7.6 mm
Dibsi Faraj East	7.7 mm	1.1 mm	6.1 mm	10.5 mm	4.4 mm
Rosh Horesha	6.2 mm	2.0 mm	2.85 mm	10.25 mm	7.4 mm
Rosh Zin	6.1 mm	1.3 mm	3.25 mm	9.9 mm	6.65 mm
Mugharet el-Kebarah	7.6 mm	1.5 mm	4.9 mm	10.8 mm	5.9 mm
Mugharet el-Wad B2	6.0 mm	1.8 mm	3.0 mm	11.0 mm	8.0 mm
Nahal Oren	4.2 mm	0.8 mm	2.95 mm	7.55 mm	4.6 mm

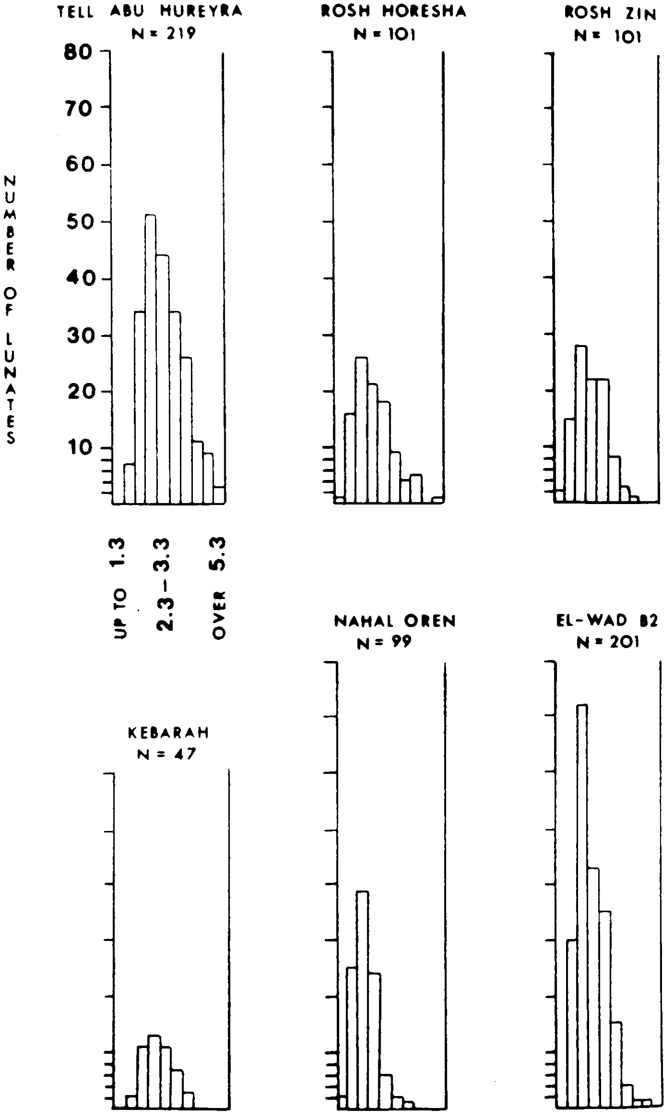


Figure 21. Histograms for thickness of lunates from selected late Epipaleolithic sites (in mm.).

Table 22. Metric information on lunate thickness for selected late Epipaleolithic sites.

Site	Mean	Standard Deviation	Smallest Value	Largest Value	Range
Tell Abu Hureyra	3.1 mm	0.8 mm	1.45 mm	5.95 mm	4.5 mm
Dibsi Faraj East	3.4 mm	0.8 mm	2.3 mm	4.75 mm	2.45 mm
Rosh Horesha	2.6 mm	0.8 mm	1.2 mm	6.3 mm	5.1 mm
Rosh Zin	2.5 mm	0.6 mm	1.25 mm	4.45 mm	3.2 mm
Mugharet el-Kebarah	2.7 mm	0.6 mm	1.7 mm	4.3 mm	2.6 mm
Mugharet el-Wad B2	2.4 mm	0.6 mm	1.35 mm	5.25 mm	3.9 mm
Nahal Oren	2.1 mm	0.5 mm	1.3 mm	4.2 mm	2.9 mm

Table 23. Shape analysis using mean length, width at midpoint and thickness of lunates for selected late Epipaleolithic sites.

Site	Mean Length	Mean Width at Midpoint	Mean Thickness
Dibsi Faraj East (N=13)	30.37 mm	7.77 mm	3.44 mm
Tell Abu Hureyra (N=219)	26.75 mm	7.16 mm	3.14 mm
Mugharet el-Kebarah (N=47)	23.57 mm	7.67 mm	2.78 mm
Rosh Horesha (N=101)	21.60 mm	6.23 mm	2.65 mm
Rosh Zin (N=101)	19.46 mm	6.11 mm	2.51 mm
Mugharet el-Wad B2 (N=201)	19.82 mm	6.04 mm	2.45 mm
Nahal Oren (N=99)	15.80 mm	4.21 mm	2.16 mm

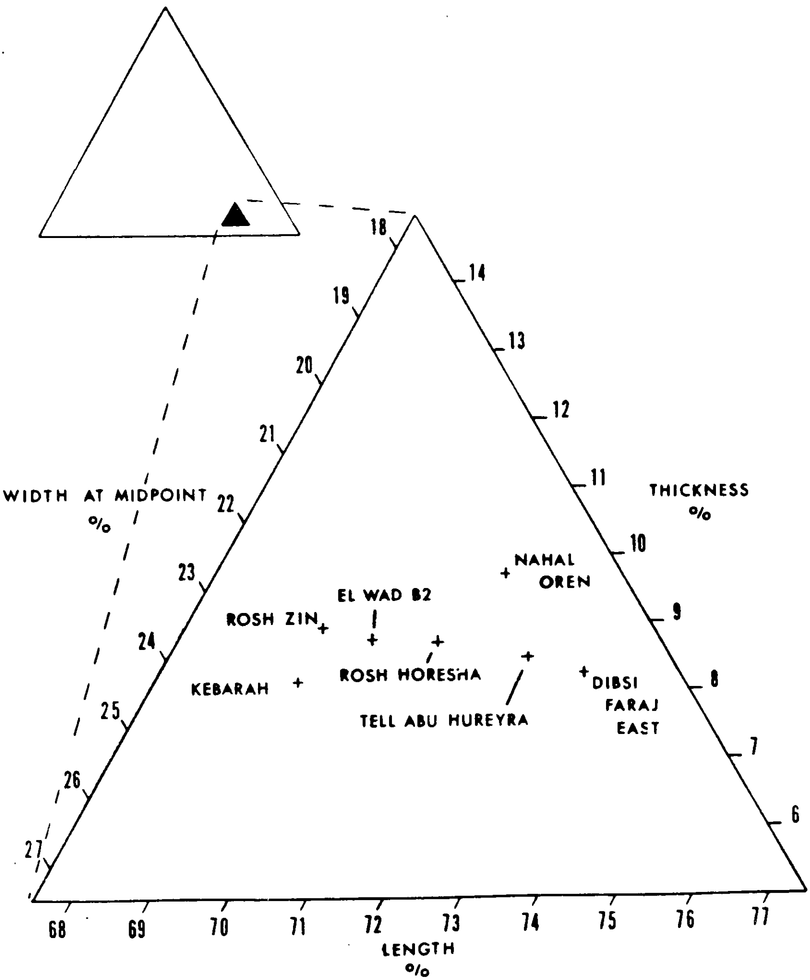


Figure 22. Triangular plot of lunate mean overall shape from selected late Epipaleolithic sites.

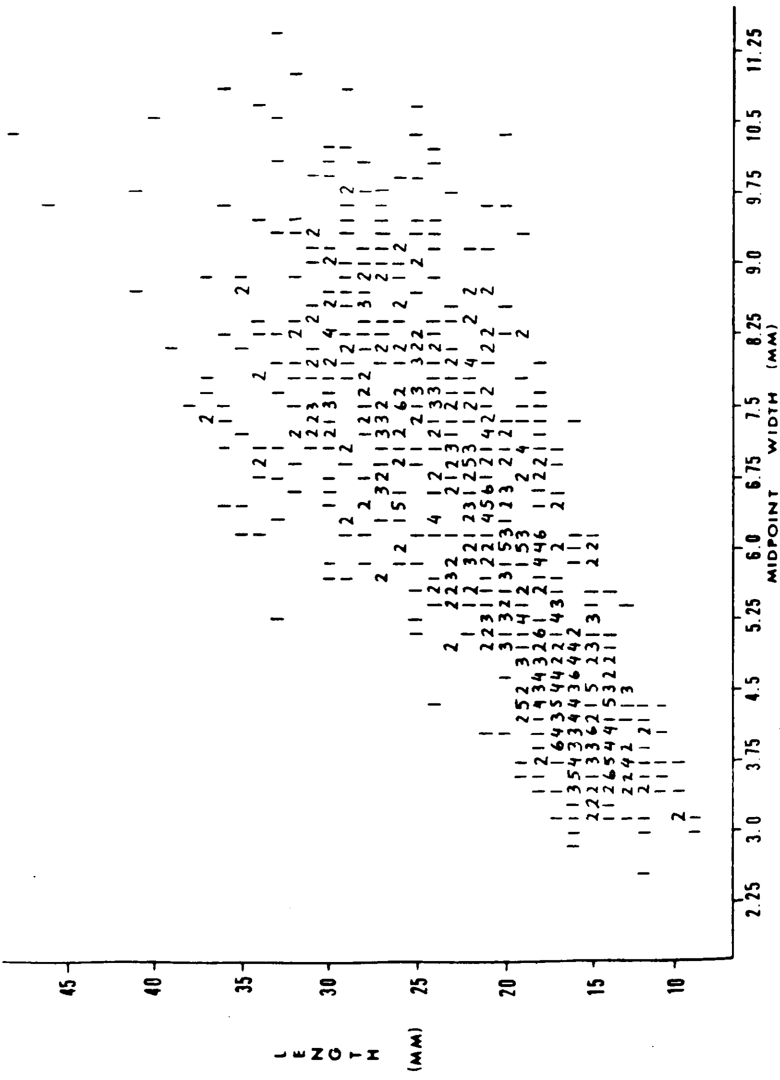


Figure 23. Lunate length plotted against width at midpoint.

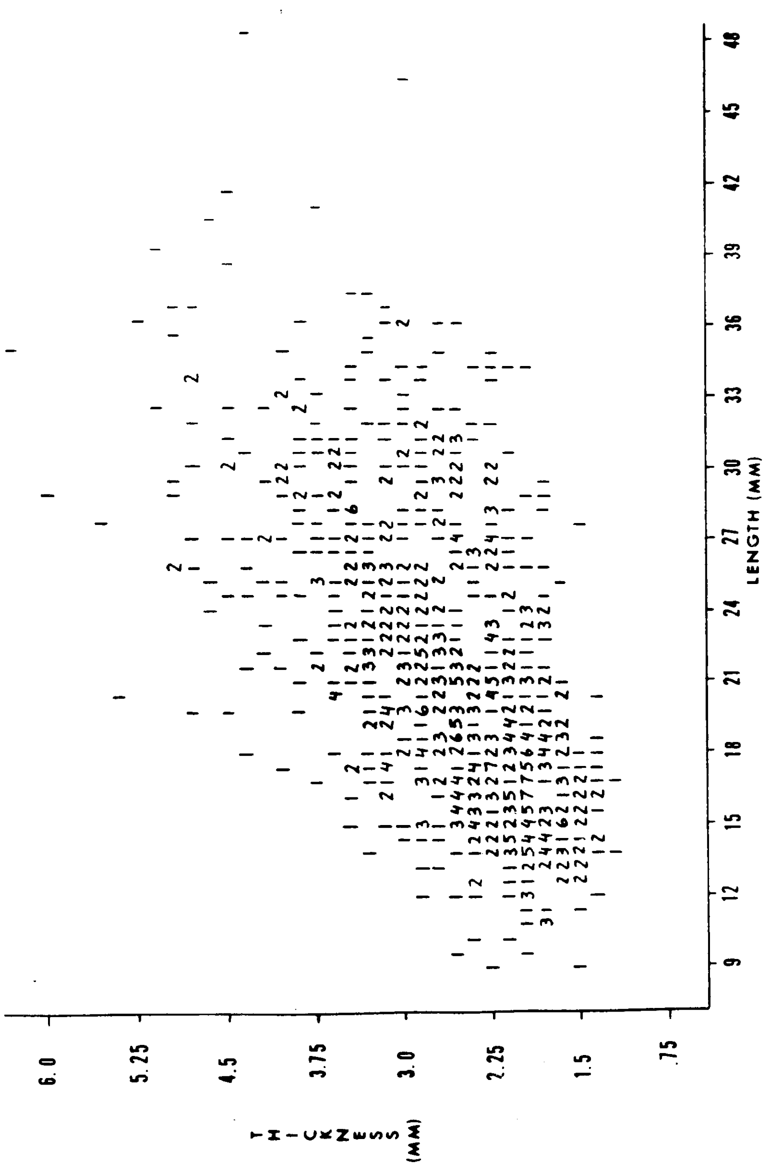


Figure 24. Lunate length plotted against thickness.

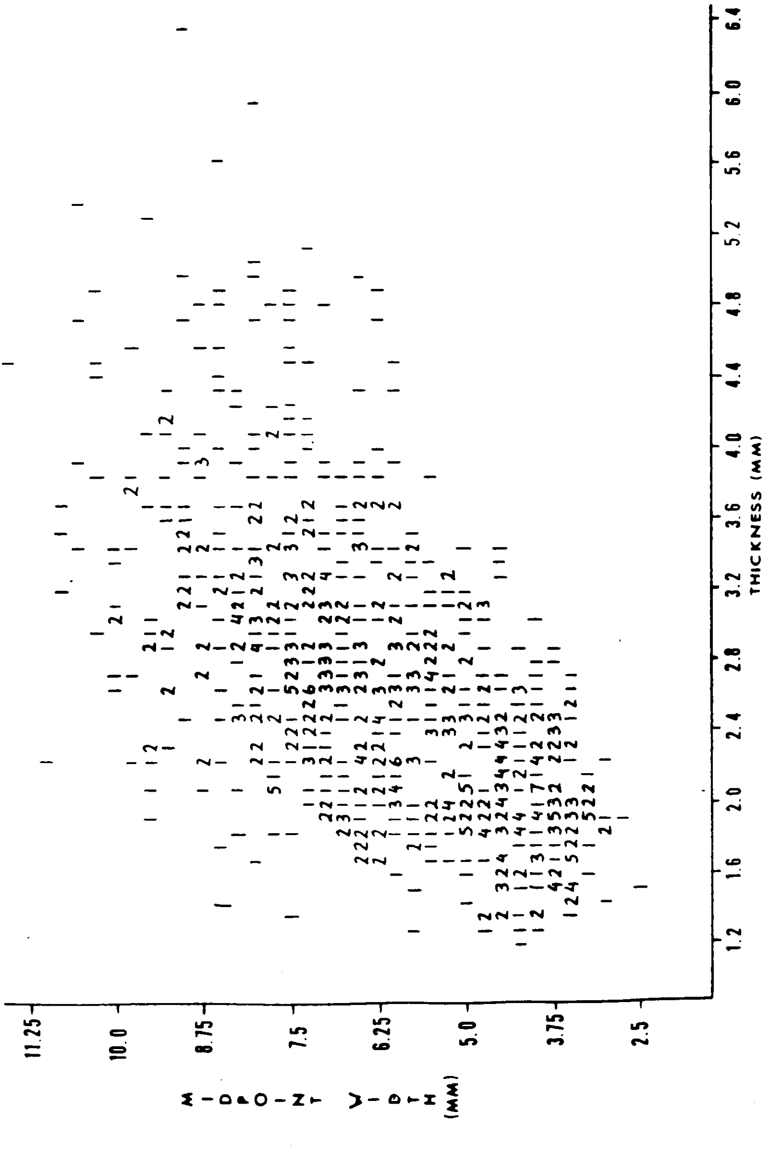


Figure 25. Lunate width at midpoint plotted against thickness.

still a tendency for larger values of width to have a larger range of associated thickness values.

When each site is examined separately for correlations between lunate length and width at midpoint, length and thickness, and midpoint width to thickness, the correlations vary somewhat from site to site (Table 24.) Only the lunate sample from Rosh-Horesha demonstrates consistently higher correlations between the variables. All other sites show either lower correlations than the combined sample, in each of the pairings, or lower correlations in two of the three pairings per site.

These metric variables, length, width at the midpoint, and thickness, present an overall shape picture of the lunates from each site. A principal components analysis, the Biomedical Statistical Program 4M (Frane et al. 1983), using these three variables in conjunction with width, shows that the length variable explains the greatest amount of the variance (Table 25). Thickness explains a very low proportion of the variance. This is undoubtedly because the length variable has a much greater range of values than the thickness variable. It is precisely this greater range of values that allows the apparent chronological separation of late Epipaleolithic sites.

Using the length variable, the samples from Tell Abu Hureyra, Mugharet el-Wad B2, Mugharet el-Kebarah, Rosh Horesha, Rosh Zin, and Nahal Oren, were tested against each other. The Scheffé method for multiple comparisons of group means with the F-distribution was used (analysis of variance) (Turney and Robb 1973:132). The results obtained in the pair by pair comparisons against both the .95 and .99 levels of significance are presented in Table 26. The data used for the statistical calculations are from the measurements presented in Appendix E.

There are only four site to site comparisons that are not significant at either the .95 or the .99 level. These are Mugharet el-Wad B2 with Rosh Horesha, Mugharet el-Wad B2 with Rosh Zin, Mugharet el-Kebarah with Rosh Horesha, and Rosh Horesha with Rosh Zin. The comparison of Tell Abu Hureyra with Mugharet el-Kebarah is statistically significantly different at the .95 level, but not at the .99 level. The fact that the Mt. Carmel sites (Mugharet el-Wad and Mugharet el-Kebarah), dated to the 10th millenniuum, and the Negev sites (Rosh Horesha and Rosh Zin), dated to the 9th millennium, exhibit statistically non-significant differences between the means of their lunate samples, is possibly further confirmation that the average length of lunate assemblages must be separated into steppic and forest/coastal zones in order to have value as a chronological marker.

The statistically significant difference between the mean lunate lengths from Mugharet el-Wad B2 and Mugharet el-

Table 24. Correlation coefficient for paired metric measurements from selected late Epipaleolithic sites.

Site	Length to Mid-point Width R	Length to Thickness R	Midpoint Width to Thickness R
Tell Abu Hureyra	0.54	0.42	0.46
Dibsi Faraj East	0.70	0.28	0.47
Rosh Horesha	0.84	0.66	0.69
Rosh Zin	0.74	0.49	0.49
Mugharet el-Kebarah	0.79	0.38	0.34
Mugharet el-Wad B2	0.77	0.46	0.43
Nahal Oren	0.68	0.30	0.50

Table 25. Principal components factors for lunate metric measurements of samples from selected late Epipaleolithic sites.

Factor	Variance Explained	Cumulative Proportion of Total Variance
1. length	3.8225	.7645
2. width at midpoint	0.558611	.876222
3. width at widest point	0.49656	.975534
4. length to width at widest point	0.114078	.998350
5. thickness	0.008251	1.000000

Table 26. Analysis of variance for the difference between the mean lunate length of samples from selected late Epipaleolithic sites.

Sites	Calculated F	F at .95	F at .99
Tell Abu Hureyra/ Mugharet el-Wad B2	37.49	2.21	3.02
Tell Abu Hureyra/ Nahal Oren	60.55	2.21	3.02
Tell Abu Hureyra/ Mugharet el-Kebarah	2.91	2.21	3.02
Tell Abu Hureyra/ Rosh Horesha	3.55	2.21	3.02
Tell Abu Hureyra/ Rosh Zin	7.12	2.21	3.02
Mugharet el-Wad B2/ Nahal Oren	7.87	2.21	3.02
Mugharet el-Wad B2/ Mugharet el-Kebarah	3.99	2.21	3.02
Mugharet el-Wad B2/ Rosh Horesha	1.58	2.21	3.02
Mugharet el-Wad B2/ Rosh Zin	0.06	2.21	3.02
Nahal Oren/ Mugharet el-Kebarah	14.22	2.21	3.02
Nahal Oren/ Rosh Horesha	12.39	2.21	3.02
Nahal Oren/ Rosh Zin	4.90	2.21	3.02
Mugharet el-Kebarah/ Rosh Horesha	0.92	2.21	3.02
Mugharet el-Kebarah/ Rosh Zin	4.03	2.21	3.02
Rosh Horesha/ Rosh Zin	1.72	2.21	3.02

Kebarah suggests that Valla's phase delineation of the Natufian cannot be supported statistically, at least for all cases. Without the benefit of an extensive array of C-14 dates from numerous late Epipaleolithic sites, the actual placement of sites into Valla's phase system cannot be fully tested.

Apparently, neither the simple equivalence of time and lunate length, nor the scheme presented by Valla (1981), that uses lunate length in conjunction with the relative frequency of Helwan retouch, adequately explains the chronological variability present among late Epipaleolithic sites. The real question becomes whether or not a chronological assessment can be made using these variables. If the dimension of environmental zone is added to the assessment of the chronological significance of lunate length and Helwan retouch, a somewhat clearer picture for Natufian sites emerges (see Fig. 17). Sufficient data are not available for the other areas.

Figure 26 presents lunate length plotted against percentage of Helwan retouch. The forest/coastal group of Mugharet el-Kebarah, Ain Mallaha, Mugharet el-Wad, Hayonim Cave, and Nahal Oren, shows a clear relationship between lunate length and Helwan retouch (data are from this study and from Valla 1981). This is demonstrated by the placement of lower to upper levels at Ain Mallaha, Hayonim Cave and Mugharet el-Wad. The correlation between Helwan retouch and lunate length is .75 (.94 without the small sample of nineteen lunates from Hayonim Cave lower B).

At the steppic sites of Rosh Horesha, Rosh Zin, Shukbah, Salibiyah I, Tor Abu Sif, Oumm ez-Zoueitina, Erq el-Ahmar A-2, and Beidha, lunate length tends to be larger on the average during each of Valla's phases than in the forest/coastal zone. This suggests that it may be important to consider the environmental region before assessing chronological placement based on lunate length and Helwan re-touch for Natufian sites. Alternatively, since documentation of the decrease in the relative frequency of Helwan style re-touch through time is not currently available for steppic sites, there is no reason to automatically assume that the frequency of Helwan style re-touch there is an accurate reflection of temporal sequencing.

Finally, the three northern Syrian sites, Tell Abu Hureyra, Tell Mureybat and Dibsi Faraj East, apparently show a decrease in lunate length through time, but do not show Helwan retouch for any time period. This may be further confirmation that different industries exist in the northern and the southern Levant.

Tell Abu Hureyra: Additional Lunate Attributes

Several additional nonmetric observations were made on samples of 186 complete lunates from Tell Abu Hureyra.

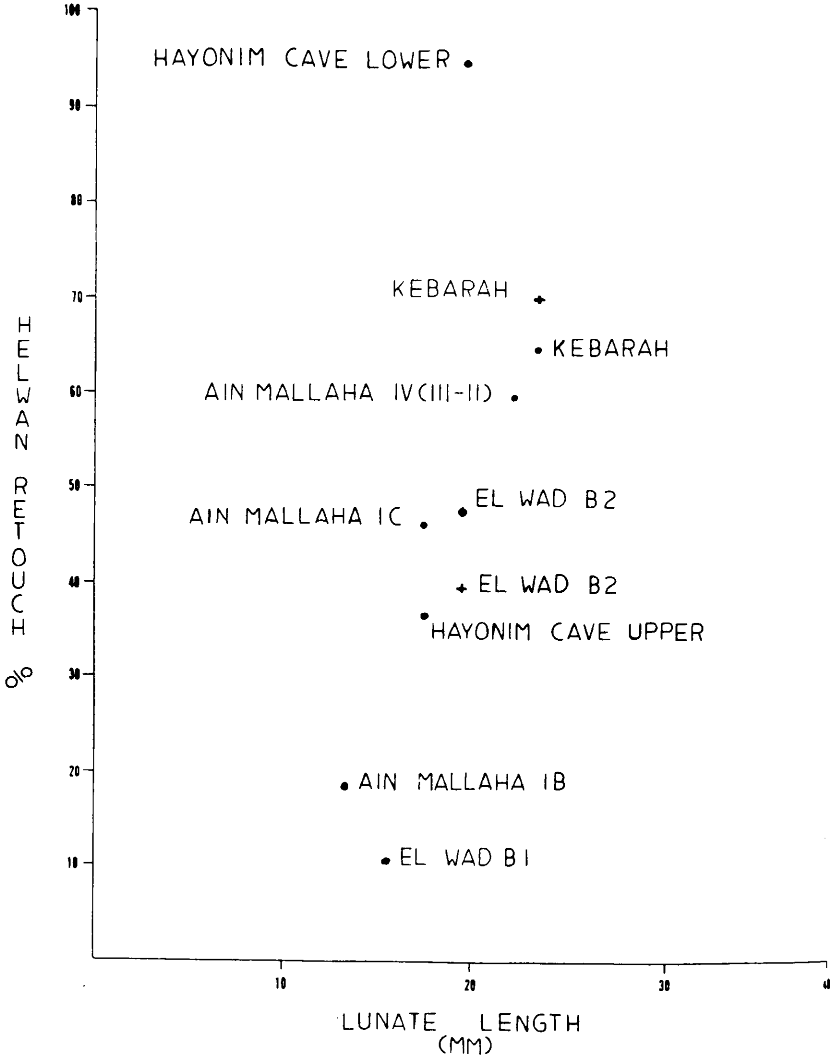


Figure 26. Plot of Helwan retouch precent against mean lunate length for forest/coastal late Epipaleolithic sites.

Lunates from levels above 280 in these comparisons were only from flotation sample residue, not from the trench and sieve samples. These additional nonmetric observations include modification of both pointed tips, modification of the unretouched edge, the type of modification, where applicable, and the presence/absence of polish visible to the naked eye.

Several retouch types were present (Table 18). These are illustrated in Appendix B (Figs. B-15 - B-17).

The lunate tips displayed one or more of the following characteristics. The greatest majority were intact. These were followed by tips that had just the most extreme portion of the tip broken off. A few tips showed small burinations, originating at the point and paralleling the unretouched edge. A small number of the tips had been reworked into perforators or had simply been re-touched. One tip still had a portion of the striking platform. The data from the 372 lunate tips is summarized in Table 27. Examples of each of the tip categories are shown in Appendix B (Figs. B-15 - B-17.

The intact tips need no explanation. The broken tips might have resulted from a variety of natural causes, such as ancient trampling, transport with other flint artifacts, breakage against sieve mesh in dry sieving and flotation, or breakage during excavation. The single striking platform tip indicates a lack of complete reduction of this tip. Thus, there are only 61 lunate tips that show evidence of functional or deliberate modification. The reworked and perforator tips are deliberate modifications to the lunates that expand the range of versatility of these tools. The small burinations are difficult to explain, but may be either the result of several flints hafted side by side, that were loose enough to knock against one another during use of the composite tool, or the result of an oblique blow to the tip. This latter explanation is especially likely if, as Anderson-Gerfaud (1983) suggests, they were hafted in such a manner that one of the tips served as an arrow tip.

The unretouched edge was also examined. Of the sample of 186 lunates, 116 showed no visible modification under a hand-held 10 x lens. The visible modification on seventy lunates can be grouped into six categories. These are nibbling (an irregular damage along the edge), notched, denticulated, abrupt retouch, invasive retouch, and fine re-touch (consisting of small, regular retouch scars). The results are summarized in Table 28 and several examples are illustrated in Appendix B (Figs. B-15 - B-17). The nibbling damage, since it is irregular in form, may be due to transport and excavation damage. However, without microwear analysis of such lunates, culturally produced damage cannot be ruled out. The other five types of modification indicate a deliberate intention to alter the working edge of the lunate.

Table 27. Lunate tip information from the Tell Abu Hureyra sample.

Lunate Tip Categories					
intact	burinated	broken	reworked	perforator	striking platform
183	34	127	17	10	1

N = 186 total lunates (2 tips per lunate)

Lunate Tip Combinations	
intact/intact	49
intact/burinated	15
intact/broken	65
intact/reworked	3
intact/perforator	2
intact/stiking platform	-
burinated/burinated	2
burinated/broken	8
burinated/reworked	5
burinated/perforator	2
burinated/striking platform	-
broken/broken	24
broken/reworked	3
broken/perforator	2
broken/striking platform	1
reworked/reworked	3
reworked/perforator	-
reworked/striking platform	-
perforator/perforator	2
perforator/striking platform	-
striking platform/striking platform	-
Total	186

Table 28. Lunate edge modification from the Tell Abu Hureyra sample.

Lunate Edge Modification			
None	Present	Type	
116	70		
		nibbling	44
		notched	7
		denticulated	3
		abrupt retouch	2
		invasive retouch	9
		fine retouch	5
			70

Finally, the unretouched edge was also examined to ascertain if a high gloss polish, similar to that seen on sickle blades, was present. Of the 186 lunates, only five had polish visible to the naked eye, and nine had minute traces of polish. This indicates that lunates may not have been used on the same types of materials as were sickle blades, or at least not as intensively used on silicious plants. It does suggest that not all lunates were arrow tips or barbs. Examples are shown in Appendix B (Fig. B-15).

Ten lunates were found to have traces of the original mastic adhering to the backed edges. Examples of these are shown in Appendix B (Figs. B-15, B-17).

The lack of major modification of most lunate tips and unretouched edges indicates that the lunate form was rarely reworked into other tools. In addition, the scarcity of polish visible to the naked eye suggests that lunates, singly or in composite tools, were either used for tasks different from the use of sickle blades, were less intensively used at these tasks, or were used on plants possessing less silica than plants cut by sickle blades. Of course, the final determination of the task specific role of lunates can only be resolved by a serious microwear study of lunates from several sites.

Significance and Interpretation of Lunates

The lunate microlith is interesting from several points of view. Historically, they indicated to Garrod in 1928 at Shukbah (Garrod 1942) that she had discovered Epipaleolithic deposits, and later, in conjunction with the presence of Helwan retouch (Garrod 1932), that the Levantine late Epipaleolithic was not of Capsian origin.

The lunate, being a microlithic tool, was probably most often used in conjunction with other microliths to form composite tools of various sorts. Archaeological examples of these include the double lunate projectile point from Egypt (Clark 1975-1977:137, Plate IIIA, no. 3). Use of microliths, including lunates, as single projectile point tips is also known from Egyptian (Clark et al. 1974:334) and Western European Mesolithic sources (Odell 1978), as well as ethnographically (Allchin 1966). The lunate in its role as a part of a composite tool could therefore have served many functions.

Recent microwear studies of lunates from Ain Mallaha and Mugharet el-Wad (Büller 1982:9), and by Anderson-Gerfaud (1983) at Tell Abu Hureyra and Tell Mureybat, have shown that these have a dull meat polish. Buller uses his information to suggest that lunates were part of composite projectile points, and that Mugharet el-Wad was a specialized activity camp, based on the additional fact that all notches examined were used to cut tendons from bones.

This viewpoint is in contrast to the commonly held notion that Mugharet el-Wad was a base camp (Bar-Yosef 1970a:177; Henry 1973b:176). Consideration of all aspects of the cultural asssemblage from Mugharet el-Wad, burials, bed-rock mortars, structures, sickle blades, and so forth, suggests that Büller's opinion is too narrow. The functional interpretation of a small sample of various tools may indicate the prevalence of certain activities in which these tools were employed, but should not be taken as the sole explanation for site activity. It would be interesting to know if the lunates examined by Büller were of the Helwan type or the abrupt/anvil type.

Finally, with respect to Büller's interpretation of the presence of meat polish as indicating the lunates were parts of composite projectile points, the question of the length of time required to produce polish on the tool must be asked. If such polish is not formed after a small number of uses as a projectile, then lunate use as a projectile must be doubted, and the presence of meat polish must indicate some other sort of use on meat products, such as use as a knife (Allchin 1966).

The length of the lunate has preliminarily proved to be a chronological indicator for periods within the late Epipaleolithic. Studies by Bar-Yosef and Valla (1979) and Valla (1981) have shown that length appears to decrease through time, along with a decrease in the popularity of Helwan retouch. The study presented in this chapter suggests two amendments to this scheme. On the one hand, the importance of the distinct environmental zone patterns has been overlooked in previous work. Thus, within present limits of chronological control, lunates from forest/coastal sites (Mugharet el-Wad, Mugharet el-Kebarah, Nahal Oren, Ain Mallaha, Hayonim Cave) appear to be smaller than contemporary examples from sites in the steppic regions (Rosh Horesha, Rosh Zin, Beidha, Oumm ez-Zoueitina, Tor Abu Sif, Erq el-Ahmar A-2. Shukbah, Salibiyah I). Two exceptions to this pattern occur. Both Shukbah and Oumm Qala'a do not group with their respective environmental zones.

The north Syrian area is an important separate geographical region. While a decrease in the length of lunates apparently also occurs here, Helwan retouch is absent throughout the sequence from Tell Abu Hureyra to Tell Mureybat, and therefore, this form of retouch cannot be used in chronological assessment there.

On the other hand, the three phase division of the Natufian suggested by Valla (1981) cannot be supported statistically. The actual placement of sites into one or the other of the phases seems to be a somewhat subjective process based on mean lunate length and Helwan retouch frequency. It is not entirely clear whether or not this format can be extended to sites that do not have Helwan retouched lunates.

An explanation of why these trends and differences occur is difficult to advance based on the currently available data. However, they are undoubtedly the results of a complex interaction between chronology, environmental zone, activity orientation, and stylistic acceptance/preference. In this context, it may be useful for microwear analysts to examine the relationship between the uses of Helwan versus abrupt/anvil style retouched lunates, as well as those between relatively long versus relatively short lunates. It is possible that functional differences related to activity orientation at particular sites partially dictate the character of the lunate assemblage. This, in fact, is suggested in Anderson-Gerfaud's study (1983), where larger lunates tend to be hafted as transverse arrowheads, while smaller lunates are either arrowbarbs or hafted with one tip serving as the arrow tip.

Summary

The lunate is a microlithic tool type characterized by one convex backed edge, which has as its utilized side a generally straight, unretouched edge. In the Levant, the lunate is a common component of microlithic assemblages dating to the late Epipaleolithic, ca. 10,500 to 8,300 b.c. As such it has been found at sites throughout Palestine, the Negev Desert, Lebanon, Syria, and Jordan.

Of the three measurements of lunate size, length, width, and thickness, the length measurement has proved to be the most useful for differentiating between sites and through time. Lunate length apparently decreases through time throughout the Levantine area. This trend is independent of geographical region. However, the study presented in this chapter suggests that differences in absolute length of lunates for any given time interval varies from one environmental zone to another. Thus, lunates from forest/coastal zone sites are generally smaller than their counterparts from sites in the steppic areas.

Helwan style retouch was commonly employed to back lunates during the early periods of the late Epipaleolithic within the Natufian area. Apparently, this retouch style was used throughout the 10th milennium, after which it disappeared. Thus it can be used in conjunction with lunate length to indicate chronological placement. This particular retouch style is found only spradically in northern Syria. Therefore, its value as a chronological indicator for this area is at present unknown.

In general, lunates that are absolutely longer tend to be absolutely wider and thicker. Those that are short tend to be narrower and thinner. Thus, there is a strong consistency in form, that is reflected throughout the late Epipaleolithic time period. Longer lunates appear to have more variabilaity in the range of thicknesses and widths displayed, while shorter lunates have less. This probably reflects a certain minimum limit for size dimensions of lunates, as well as an overall size reduction through time.

A sample of 186 lunates from Tell Abu Hureyra was examined for nonmetric and metric attributes. These included whether or not the lunate tips had been modified, if the unretouched edge had been modified, and if polish visible to the naked eye was present on the lunate. The greatest majority of the lunate tips were either intact or slightly damaged, probably as a result of transport and sieving, rather than deliberate modification. A few of the tips had been retouched or fashioned into perforators. Some showed small burinations, possibly resulting from use in composite tools where lunates were set tip to tip, or from use as arrow tips. The majority of unretouched edges had not been modified. Those that were showed notches, denticulations, fine, abrupt, or invasive retouch, or nibbling. The nibbling is an irregular damage that may or may not be cultural. Finally, only thirteen lunates had polish or traces of polish. This was of a dull lustre, unlike the sickle gloss found on sickle blades at Natufian sites. On the whole, these nonmetric attributes suggest that lunates generally were not modified beyond the shaping of the lunate form.

Lunates, as parts of composite tools, probably served a variety of functions. Known archaeological examples indicate that they were hafted as projectile points (i.e., in Egypt). Microwear studies on a total of twenty lunates from Mugharet el-Wad and Ain Mallaha, and on a small sample from Tell Abu Hureyra and Tell Mureybat, show these to have a dull meat polish. This has led to the belief that they were used as parts of composite projectile points or as arrowheads. However, it is not clear how many times such a projectile would need to be used before such polish occurred; it is equally possible that this sample represents composite tools used on meat in a manner other than as projectiles.

CHAPTER 7

SUMMARY AND CONCLUSIONS

Overview

The Levantine late Epipaleolithic, which lasted from about 10,500 to 8,300 b.c., includes evidence of several significant cultural, and perhaps social, changes. In contrast to the preceding early Epipaleolithic, which includes the Kebaran, Geometric Kebaran A, Mushabian, and Negev Kebaran, the late Epipaleolithic shows an increase in the overall number of sites, an increase in the diversity of site location, and the appearance of sites with occupation areas exceeding 400 m2. Sites such as Rosh Horesha, at 7,000 m2, Rosh Zin, at 900 m2, and Ain Mallaha, at 2,000 m2, are prime examples of large late Epipaleolithic sites. IN addition, many of these late Epipaleolithic sites have evidence of significant labor investment in the form of architectural features. Most often these are circular excavated pits or stone walled pits, which are usually interpretated as the remains of huts. These features are present as far south as Rosh Horesha and Rosh Zin in the Negev Desert, as far north as Tell Abu Hureyra along the Euphrates River in northern Syria, and as far east as Beidhain the Transjordan. Certain sites have yet other structural features. Thus, for example, there are plastered pits for storage at Ain Mallaha,a wall and leveled bedrock area at Muharet el-Wad, and a clay platform at Jericho. In contrast, only a single known hut structure from the early Epipaleolithic has been found, at the Kebaran site of En Gev I.

Ground stone and burials also appear in great quantities for the first time at many of the late Epipaleolithic sites. In the Natufain area, comparising Palestine and extending into the Transjordan, ground stone often occurs in the form of mortars and pestles, while the northern Syrian region has a predominance of rubbers and querns. Numerous burials were found at Murgharet el-Wad, Ain Mallaha, Nahal Oren, and Hayonim. Burials were also found at Shukbah, Erg el-Ahmar, and Mugaret el-Kebarah. The early Epipaleolithic, on the other hane, has only sporadic occurances of ground stone, at Ein Gev I, Hefzibah, Nahal Hadera V, and Haon III, and only one known burial, from the Kebaran at Ein Gev I.

A florenscence in the manufacture of bone tool forms, art objects and ornaments occurred in the Natufian area during the late Epipaleolithic. Bone tool items included awls, needles, hooks, harpoons, spatulae, gorgets, points, pendants, and sickle hafts. Sickle hafts were frequently decorated, the most famous example being the ruminant carved on a sickle haft from Mugharet el-Kebarah. Dentalium shell caps were found with some burials at Mugahret el-Wad, as well as a necklace of paired, pierced gazelle phalanges. Pierced deer canines also occurred. Figures carved in stone included ruminants from Qumm ez-Zoueitina and Mugharet el-Wad, heads from Mugharet el-Wad and Ain Mallaha, and the embracing couple from Ain Sahkri. Carved designs on stone bowls or mortars were found at Ain Mallaha.

A major change in the chipped stone tool assemblage was the predominance of the lunate microlith over the earlier favored rectangles and trapezes. Borers and heavy tools also took on increased importance.

These changes in the archaeological record of the Levant may be due in part to the influence of a climatic amelioration that began prior to 12,000 b.c. This amelioration, in the form of increased temperature and precipitation, allowed an expansion of environmental zones, such as the Mediteranean forest, the open forest, and the steppe. Such an expansion implies that the plant and animal resources available to late Epipaleolithic groups might have been greater in quantity than those available during much of the early Epipaleolithic. The establishment of medium to large settlements with structures indicated a degree of permanance of occupation, although this need not have been year-round, except perhaps at particularly favorable locations, like Jericho, Ain Mallaha, and Tell Abu Hureyra. The appearance of large quantities of ground stone suggests that late Epipaleolithic groups were processing plant foods, although some ground stone shows use for ochre grinding. In addition, recent research at Nahal Oren and Tell Abu Hureyra has documented, through flotation recovery, the presence of numerous plant foods, such as legumes, vetches, various grass seeds, grape pips, and wild einkorn. Sickle blades, with the high lustre known as sickle gloss, from the Natufian area, also attest to intensive plant use. This is a pattern not seen during the early Epipaleolithic.

The question of animal domestication during the late Epipaleolithic, in particular, gazelle domestication, has not been satisfactorily resolved. Current evidence, which is primarily based on the percentage of immature animals in each sample, indicates that this percentage is highly variable from site to site, even into the subsequent Neolithic periods where domestication of sheep and goats has been more firmly documented. Proponents of gazelle domestication have suggested that this may have taken the form of animal husbandry. If this the the case, this is probably a pattern practiced by many hunter-gatherer groups throughout much of prehistory. Since groups relying on animals as food must have been aware of which culling strategies were most appropriate for the continuance of the herd, this could well be a hunting strategy rather than a form of domestication.

Comparisons Between Different Levantine Areas During the Late Epipaleolithic

Developments during the late Epipaleolithic in the Levant can be broadly grouped into two regions at present. These two areas are northern Syria, especially the Euphrates River area, and the Natufian region, comprising Palestine, the Negev Desert, the northern Sinai Desert, and Jordan. Southern Syria and Lebanon may eventually be included in the Natufian area, but the evidence to date is too meagre to be definitive.

The Natufian area includes the majority of known sites dating to the late Epipaleolithic. This is a factor of the early and continuing research there. The late Epipaleolithic was first defined in this region in 1928 at the cave of Shukbah by D. A. E. Garrod. Her definition has been added to and refined over the past two decades. The Natufian has come to be synonymous with lunate microliths, sickle blades, scrapers on blades, perforators and borers, heavy tools, pyramidal cores, abundant ground stone, burials, a rich and varied bone industry, as well as stone carving and ornaments, and in its early phase, with Helwan retouch.

It was assumed by many, including Garrod herself, that Natufian groups practiced agriculture. Although flotation techniques have only recently been utilized during the course of excavation at one site (Nahal Oren), preliminary evidence appears to indicate that Natufian agriculture is an overstatement of the extent of plant manipulation by these prehistoric groups. Certainly, the sickle blades attest to the fact that some sort of intensive plant collection was occurring at some sites, just as the plastered pits at Ain Mallaha suggest storage facilities for plant foods. While it is entirely possible that the cultivation of some cereal grains which retained wild morphology occurred, primary evidence is still lacking. Since wild type grains could not be efficiently harvested with sickle blades, because the brittle rachis would shatter and the grain would be lost too easily, it is likely that sickle blades were used on plants other than cereal grains, such as reeds. Mortars and pestles may have served to process acorns, as Moore (1978:71) has suggested.

There are many similarities between the late Epipaleolithic cultural assemblages in the Natufian area and northern Syria. These include a dominance of lunate microliths, straight backed bladelets, a heavy tool component, and the presence of circular hut structures, and ground stone. The results of Euclidean distance coefficients, cluster analysis, and principal components analysis of tool assemblages from Levantine late Epipaleolithic sites (Tell Abu Hureyra, Dibsi Faraj East, Black Desert 14/7, Rosh Horesha, Rosh Zin, J2 and 406a in southern Jordan, Mugharet el-Wad, Mugharet el-Kebarah, Nahal Oren, Hayonim Cave, the Hayonim Terrace, Ain Mallaha, and el-Khiam) suggest that these sites shared similar patterns of chipped stone tool use with regard to the exploitation of the steppe and Mediterranean forest zones. These analyses used the general tool classes of scrapers, borer/perforators, burins, geometric microliths, nongeometric microliths, and notch/denticulates.

These analyses partially support earlier work by Henry (1977:237), but seek more precise definitions of ralationships that may be responsible for the grouping of particular sites. Thus, sites in steppic regions (Tell Abu Hureyra, Dibsi Faraj East, Black Desert 14/7, 406a, J2, Rosh Horesha and Rosh Zin) appear to be characterized by relatively high percentages of borer/perforators and notch/denticualtes (relative to all sites used in the analyses).

Two groups of sites in Mediterranean forest environments occur. Ain Mallaha, Nahal Oren and Hayonim Terrace have relatively high percentages of nongeometric microliths. Mugharet el-Wad, Mugharet el-Kebarah and Shukbah have relatively high percentages of geometric microliths. The existence of these two groups that partially share the same environmental zone may be due to activity orientation, chronological factors relating to temporal differences in microlithic components of assemblages, stylistic preferences, sampling biases of early excavations, or a combination of these factors.

Finally, one grouping (el-Khiam and Hayonim Cave) appears to be the result of activity foci, perhaps within a larger site area. Both sites have relatively high percentages of scrapers and burins. However, they are located in different environmental zones and do not support the relationship of environmental zones and relative tool frequencies that characterize the other three groups.

In addition, the scraper and burin percentages as opposed to notch/denticulate and borer/perforator percentages from the site assemblages examined exhibit an interesting chronological feature. At sites with more than one stratigraphic level dating to the late Epipaleolithic, the percentage of notch/denticulates and borer/perforators increases through time. This may reflect an increase in the importance or intensity of the activities associated with the use of these tool groups. In addition to this, there is also an apparant increase in the manufacture of geometric microliths through time, and a decrease in the production of nongeometric microliths.

When general tool classes are subdivided into specific types, significant differences appear between the north Syrian and the Natufian areas. Ground stone forms in northern Syria are mainly rubbers and querns. These are types later associated, in Neolithic contexts, with grain processing. Mortars and pestles are rare. The heavy chipped stone tools in northern Syrian are predominatly various forms of gouges, axes, and blunted implements, suggesting some dependence on a particular kind of woodworking. This is in contrast to the massive scrapers, notches, denticulates and picks that comprise the Natufian heavy tool kit. There are also other differences. Pyramidal cores are not dominant in the north, instead simple single and multiple platform cores are in the majority. Most tools are manufactured on flake blanks, Sickle blades are rare, as are art objects. Bone tools are present, but have a more restricted range of types. Helwan retouch occurs only sporadically at some surface sites and in the el-Kowm area; it is not known from the stratified excavations at either Tell Abu Hureyra or Tell Mureybat. (Tell Mureybat is probably too late in the late Epipaleolithic sequence to have this type of retouch.)

Perhaps the greatest difference between northern Syria and the Natufian area is in topography and environment. The northern Syrian area was steppic prehistorically and the relative proximity of Tell Abu Hureyra, Dibsi Faraj East and Tell Mureybat to a major riverine environment (the Euphrates) is a situation unknown in the Natufian area. Flotation recovery of plant remains from Tell Abu Hureyra has indicated that morphologically wild einkorn was probably cultivated. The recovery of wild type einkorn from Tell Mureybat suggests that similar cultivation may have been occurring there. These basic differences suggest that the north Syrian assemblages from the Euphrates River area are distinct from the contemporary Natufian developments to the south in several fundamental respects. On this basis, it is suggested that the north Syrian chipped stone industries be called the north Syrian late Epipaleolithic.

Although plant foods undoubtedly played an important role in both the Natufian and north Syrian areas, the types of foods utilized and the intensity with which each species was used apparently varied. The Natufian area was largely covered by either Mediterranean forest or open forest, while north Syria was steppic with a riparian riverine environment. The Mediterranean forest cover probably limited the number and areal extent of wild grain stands and there is no evidence indicating that Natufian groups practiced forest clearance to provide areas for grain growth. The stands would probably most often be located in wadi bottoms and sides. However, a variety of fruits and nuts in the forest would be available for harvest. On the other hand, the open nature of the steppe in northern Syria, given sufficient rainfall, would have been an ideal natural habitat for massive wild grain stands. These grain stands could have been deliberately propagated with a minimum of effort by prehistoric groups. The differences in types of ground stone employed in both areas, and the rarity of sickle blades in northern Syria, suggests that activities involving plant processing, and perhaps procurement, were different.

On the other hand, faunal exploitation patterns were very similar in both areas. Prehistoric groups made use of a wide variety of species, and concentrated on the large mammals that would have been locally abundant, goat at Beidha, gazelle at Mugharet el-Wad, Mugharet el-Kebarah, Tell Abu Hureyra, Rosh Horesha, Nahal Oren, and onager at Tell Abu Hureyra, Tell Mureybat, Rosh Horesha and Rosh Zin.

Lunates

The lunate is one of the most characteristic tool types of the late Epipaleolithic and thus warrants more detailed examination and discussion than other artifact classes. It was probably used as a component of composite tools, although it may also have served in isolation as a projectile point tip. Composite tools would have included lunates hafted into wood or bone in the form of sickles, knives, and projectiles. Microwear analyses on a small sample of lunates from Mugharet el-Wad, Ain Mallaha, Tell Abu Hureyra, and Tell Mureybat shows that those examined had meat polish. This evidence has been used to suggest that these were projectiles. Some were hafted as transverse arrowheads, some as arrow barbs, and others as arrow tips, where one tip of the lunate served as the arrow tip.

Research has suggested that the length of lunates decreases through time. This is a trend that appears to occur throughout the Levantine area. In the Natufian area, this trend toward decreasing size is paralleled by a decrease in the relative frequency of Helwan retouch. In other words, sites that have lunates which on the average are short, do not have Helwan retouch. However, an analysis presented above (Chapter 6) suggests that the relationship of lunate length to time, and to Helwan retouch, also varies with environmental region. Thus, lunates at sites in forest/coastal areas are shorter, on the average, at any given time, than lunates from steppic regions. Decrease in lunate length through time is probably also characteristic of lunate assemblages form northern Syria.

Future Research

It is obvious that there are several major priorities for future investigation of the late Epipaleolithic in the Levant. There is a critical need for careful excavation of more sites with stratigraphic superposition in the Natufian area. Detailed excavations of such sites are necessary before temporal changes in the Natufian can be fully understood. The use of flotation techniques in these excavations would provide primary evidence of plant foods utilized in the Natufian, and would greatly increase understanding of the prehistoric adaptations made by that culture. Such primary goals would be supplemented by faunal, sedimentological, and palynological analyses, and collection of samples for radiocarbon dates. There are less than ten Natufian sites with even marginally reliable C-14 dates. This in itself makes the study of variability in that region difficult. The re-excavation of previously described Natufian sites with sufficient remaining deposits would have the added advantage of providing samples to use in testing bias resulting from the recovery techniques used in the early excavations. Ideally, several sites from each environmental zone within the Natufian area should be excavated to provide information on spatial as well as chronological variability within the Natufian.

A survey to locate and excavate late Epipaleolithic sites in areas outside the Natufian region is also needed. A small start has been made with the recent excavations at Tell Abu Hureyra and Tell Mureybat, as well as the Black Desert survey and the Azraq project. The excavations have provided crucial information regarding early cultivation, and indications that not all late Epipaleolithic manifestations in the Levant are Natufian. Only future research can confirm and firmly establish the regional extent of the north Syrian industry proposed here.

There is still a great deal of research that can be done with present museum collections, especially those from the early excavations. However, it is obvious that such research must utilize as much of the extant collections from each site as possible. This is the only way to avoid random and nonrandom variability existing in collections from one site or one level of one site at various institutions. A good example of this problem is the discrepancy between the Nahal Oren Level V mean lunate length from collections in Jerusalem, published by Valla (1981), and that from collections in England examined in conjunction with this dissertation research. An examination of the full collections from each context is the only way to avoid these sampling problems.

The advent of microwear studies has made it possible to know precisely on which materials certain tools were used. This information is an important adjunct to the interpretation of site activity. These types of studies on artifacts dating to the late Epipaleolithic of the Levant have only recently begun. Ultimately, however, they have the potential to significantly increase our understanding of what these industries mean in terms of human activities and lifeways.

An understanding of the cultural developments in the Levnat during the late Epipaleolithic is crucial for the interpretation of the events leading to the domestication of plants and animals in that area of the world. The research presented in this thesis has sought explanations for the variablility seen in chipped stone assemblages from sites dating to this time period. In particular, the analyses presented here have indicated that several levels of interpretation can be suggested for the variablility in these assemblages.

The comparison of general tool classes suggests that the relative frequency of tool groups representative of particular activities are different for different environmental zones. Furthermore, the tool classes of notch/denticulates and borer/perforators exhibit a chronological trend which documents an increase in the use of notch/denticulates and borer/perforators through time. One other chronological trend was also noted at sites with more than one late Epipaleolithic stratigraphic level. At these sites, the relative frequency of geometric microliths increased through time, while nongeometric microlith percentages decreased. These trends may have important implications for the interpretation of the activities for which these tool types were used.

Finally, detailed typological and technological analysis of the Tell Abu Hureyra late Epipaleolithic chipped stone assemblage suggests that such assemblages from northern Syria are distinct from those of the Natufian area. Thus, the Natufian complex is probably not a pan-Levantine phenomemon, as has been suggested by some researchers. Rather, the recognition of the distinctive character of the northern Syrian assemblages increases our awareness of the cultural complexity of the late Epipaleolithic period in the Levant.

APPENDIX A

CHIPPED STONE FROM TELL ABU HUREYRA LEVELS 280-330

Table A-1. Tools from Tell Abu Hureyra

Tool	Number	Percentage
Scrapers (16.7%)		
on flake	246	60.5
on retouched flake	9	2.2
core-like/carinated	37	9.1
denticulated	77	19.0
nosed	12	3.0
on notched piece	11	2.7
on blade	10	2.5
on retouched blade	1	0.2
double	2	0.5
scraper/plane	1	0.2
Total	406	
Perforators/Borers (5.7%)		
single perforator	71	51.4
single perforator on backed bldt	3	2.2
double perforator	2	1.4
small borer	47	34.1
large borer	10	7.2
double borer	5	3.6
Total	138	
Burins (6.2%)		
dihedral	27	17.9
on break	27	17.9
on truncation	16	10.6
multiple on truncation	3	2.0
on striking platform	36	23.8
on natural edge	32	21.2
core-like	1	0.7
transverse off lateral preparation	4	2.6
multiple	5	3.3
Total	151	
Backed Flakes and Blades (6.9%)		
backed flake	57	34.1
straight backed blade	18	10.7
convex backed tip	14	8.4
convex backed	21	12.6
undulating back	5	3.0
partially backed	21	12.6

Tool	Number	Percentage
Backed Flakes and Blades (6.9%) cont'd		
blunt tip	8	4.8
double backed	14	8.4
fragment	9	5.4
Total	167	
Composite Tools (1.0%)		
scraper-denticulate	7	29.1
scraper-burin	8	33.3
scraper-borer/perforator	2	8.3
scraper-chopper	1	4.2
notch-sidescraper	1	4.2
perforator/borer-truncation	1	4.2
perforator/borer-burin	1	4.2
multiple burin-notch	3	12.5
Total	24	
Nongeometrics (9.7%)		
pointed straight	74	31.4
convex backed tip	32	13.6
convex backed	15	6.4
undulating back	6	2.5
partially backed	39	16.5
blunt tip	16	6.8
double backed	13	5.5
backed and truncated	6	2.5
fragments	35	14.8
Total	236	
Notch-Denticulate (19.7%)		
notched flake	326	67.9
denticulated flake	94	19.5
notched blade, bladelet	48	10.0
denticulated, blade, bladelet	12	2.5
Total	480	
Truncations (5.5%)		
truncation	134	100.0
Total	134	
Geometrics (13.1%)		
lunates	277	86.6
isosceles trapeze	2	0.6
other trapeze	4	2.2
trapeze-rectangle	2	0.6
isosceles triangle	6	1.9

Tool	Number	Percentage
Geometrics (13.1%) cont'd		
scalene triangle	14	4.4
other triangle	12	3.7
Total	320	
Heavy Tools (2.3%)		
fragment (gouge, axe, blunted)	18	
gouge	12	
blunted	4	78.2
axe	9	
biface	8	14.5
chopper	3	5.5
battered piece	1	1.8
Total	55	
Retouched Pieces (10.3%)		
flakes	213	84.5
blades	32	12.7
bladelets	7	2.8
Total	252	
Various (2.9%)		
sidescrapers	38	53.5
naturally backed knife	2	2.8
backed pieces	25	35.2
Neolitnic arrowhead	6	8.5
Total	71	
Grand Total	2434	

Table A-2. Debitage from Tell Abu Hureyra.

Debitage		Number
Flakes (67.1%)		
cortical		2951
with some cortex		5685
noncortical		8708
core-rejuvenation		576
micro-flakes		8223
	Total	26144
Blades (4.2%)		
cortical		544
single crest		344
multiple crest		593
rejuvenation		163
	Total	1644
Bladelet (3.6%)		
cortical		204
single crest		725
multiple crest		408
rejuvenation		48
	Total	1385
Burin Spalls (0.5%)		
spalls		199
	Total	199
Microburins (0.2%)		
microburin		27
trihedral		3
krukowski		59
	Total	89
Pieces with Nibbling	Total	320
Debris (24.4%)		9484
	Total	9484
Hammerstones	Total	75
	Grand Total	39340

Table A-3. Cores from Tell Abu Hureyra.

Cores	Number	Percentage
single platform	184	26.6
subprismatic	7	1.0
subpyramidal	31	4.4
1 platform, adjacent faces	40	5.8
2 platform, perpendicular	72	10.4
opposed platforms, and faces	28	4.0
opposed platforms, single face	23	3.3
subdiscoidal	10	1.4
polyhedral	191	27.6
rejected core	24	3.4
core fragment	82	11.8
Total	692	

Total assemblage, Tables A-1, A-2, A-3 42467

Table A-4. Core details from Tell Abu Hureyra.

Cores Details		Number
Flake (79.2%)		
single platform		131
subprismatic		1
subpyramidal		22
1 platform, adjacent faces		37
2 platform, perpendicular		61
opposed platforms, and faces		21
opposed platforms, single face		12
subdiscoidal		10
polyhedral		184
rejected core		24
core fragments		45
	Total	548
Blade (9.2%)		
single platform		29
prismatic		3
subpyramidal		4
1 platform, adjacent faces		1
2 platform, perpendicular		7
opposed platforms, and faces		6
opposed platforms, single face		7
subdiscoidal		-
polyhedral		2
rejected core		-
core fragments		5
	Total	64
Bladelet (7.2%)		
single platform		24
prismatic		3
subpyramidal		5
1 platform, adjacent faces		2
2 platform, perpendicular		4
opposed platforms, and faces		1
opposed platforms, single face		4
subdiscoidal		-
polyhedral		5
rejected core		-
core fragments		2
	Total	50
Indeterminate (4.4%)	Total	30
	Total Cores	692

Table A-5. Other information from Tell Abu Hureyra.

Cores	Number	Percentage
Cores showing hammerstone use	73	
Tools on blades/bladelets	968	
Tools on flakes/cores	1467	
Lunate Retouch		
Broken		
abrupt	97	
anvil	24	
semi-steep	1	
Complete		
abrupt	119	
anvil	34	
fine	3	
All		
abrupt	216	77.7
anvil	58	20.9
fine	3	1.1
semi-steep	1	0.3
Total	278	

APPENDIX B

CHIPPED STONE TERMINOLOGY

There are four main sections in this appendix. The first deals with tool terminology, the second with debitage, the third with retouch types, and the fourth with terms not included in the first three categories.

Tools

Most of the following has been adapted from Tixier (1963), Bar-Yosef (1970a), and Marks (1976).

Scrapers

Scraper on flake (Figs, B-1, 2): The blank type may be any type of flake. The retouched end is generally more or less convex in shape: the retouch can extend along both lateral edges (Tixier 1963:53, Fig. 11, nos. 1-5).

Scraper on retouched flake (Fig. B-2): The blank type may be any type of flake. The retouch, located on one or both lateral edges, must differ from that constituting the scraper retouch (Tixier 1963:55, Fig. 12, no. 3).

Core-like (carinated) scraper (Fig. B-3): The blank type is a core or core-like piece, generally quite thick in cross section. There are long negative flake or blade scars on one part, that form a regular, straight edge (Tixier 1963:55, Fig. 12, no. 6).

Denticulated scraper (Fig. B-3): These are generally on thick blanks, that can be any type of flake. The scraper end is denticulated (Tixier 1963:57, Fig. 13, nos. 1-3).

Shouldered or nosed scraper (Fig. B-4): The blank type is a blade, any type flake. The retouched end forms a protrusion, with one lateral edge indented representing the shouldered variety, and two lateral edges indented as the nosed variety (Tixier 1963:57, Fig. 13, nos. 4, 5).

Scraper on notched piece (Fig. B-4): The blank type can be any type of blade, bladelet or flake. There are one or two notches on one or both lateral edges, but none distally. The notches do not form a shoulder (Tixier 1963:57, Fig. 13, no. 7).

Endscraper on blade (Fig. B-4): The blank type is a blade or bladelet. The retouched distal end is generally convex in appearance (Tixier 1963:59, Fig. 14, nos. 4, 5).

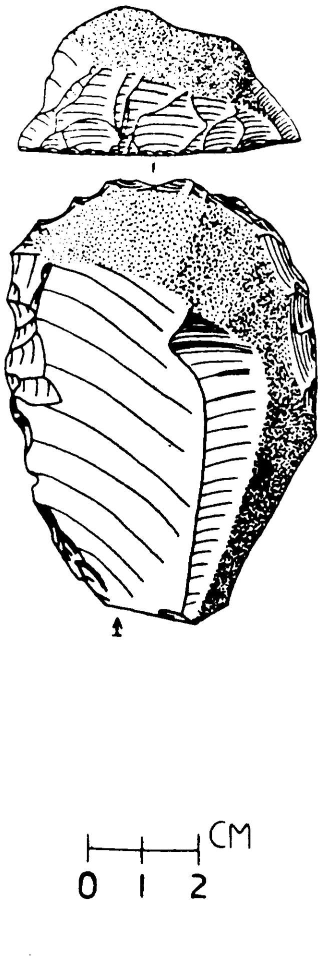


Figure B-1. Scraper on flake, Trench E, level 282.

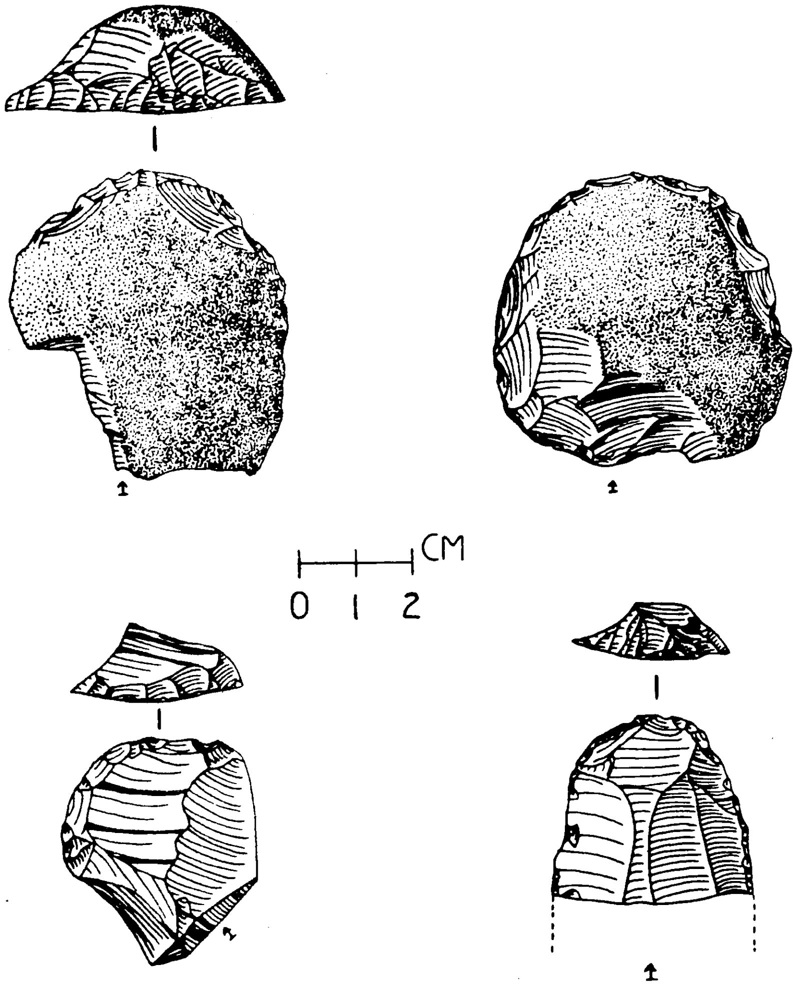


Figure B-2. Scrapers, Trench E. -- a: on flake L. 288; b: on flake L. 301; c: on flake, L. 300; d: on retouched flake, L. 294.

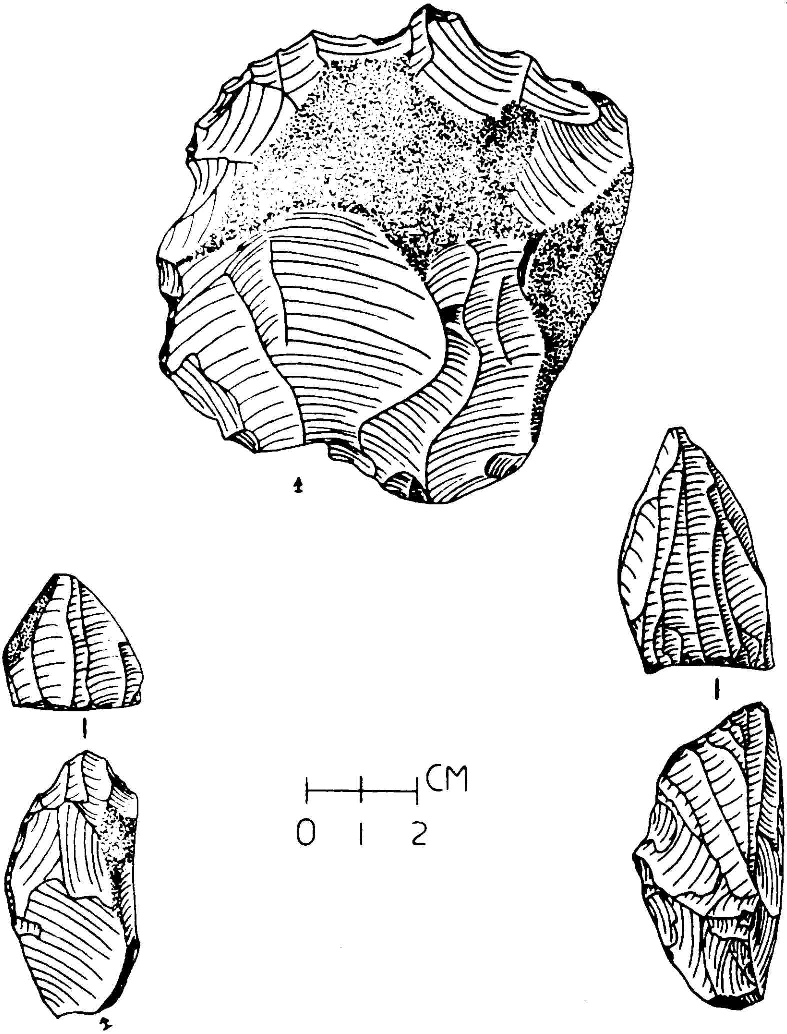


Figure B-3. Scrapers, Trench E. -- a: denticulate, L. 288; b: carinated, L. 282; c: carinated, L. 284.

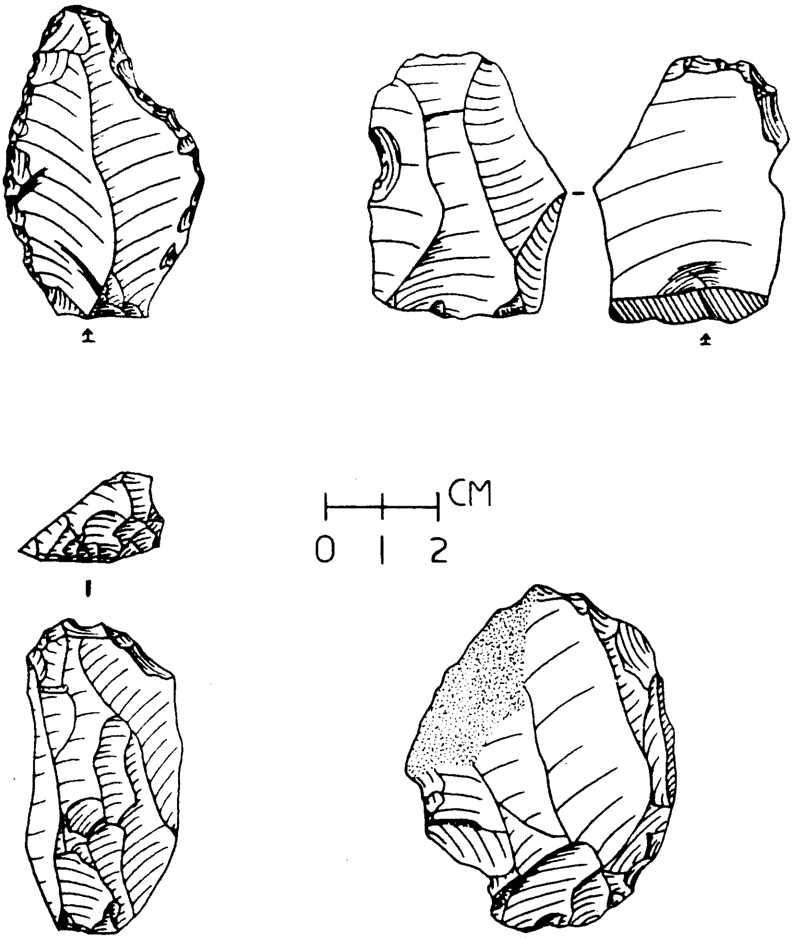


Figure B-4. Scrapers, Tench E. -- a: shouldered, L. 304; b: on notched piece, L. 282; c: on blade, L. 303; d: double, L. 305.

Endscraper on retouched blade: A blade or bladelet serves as the blank. The retouch on one or both lateral edges must differ from the retouch forming the scraper end. However, the lateral edge retouch cannot be of the abrupt variety, which would form a backed edge (Tixier 1963:60, Fig. 15, nos. 1, 2).

Double scraper (Fig. B-4): The blank type is a blade, bladelet or any type of flake. There are two opposite, nonadjacent scraper edges. The nonscraper edges may or may not be retouched (Tixier 1963:62, Fig. 16, nos. 2-4).

Scraper/plane (Fig. B-5): The blank type is generally a noncortical flake. The interior surface is flat. The scraper retouch is confined to one edge, and is characterized by long, invasive retouch scars overlain by less invasive retouch scars.

Perforator/Borer

Single perforator (Fig. B-6): The blank type is a blade, bladelet or any type of flake. The perforator is a pointed protrusion formed by convergent bilateral retouch or by adjacent notches. The perforator is pointed and thin. The aspect of thinness is not stated by Tixier (1963:62, Fig. 16, no. 5).

Single perforator on a backed bladelet (Fig. B-7): The blank is a bladelet. The perforator is a thin, pointed protrusion formed by convergent bilateral retouch, of which the backed edge may be one side. The backed edge is generally formed by abrupt retouch (Tixier 1963:62, Fig. 16, nos. 6, 8, 10).

Double perforator (Fig. B-7): The blank is any type of flake, blade or bladelet. There are two perforators formed by convergent bilateral retouch or by adjacent notches. The perforators are on different edges, but need not be opposing. They are pointed and thin protrusions.

Small borer (Fig. B-7): The blank is most often a blade or bladelet. The tip is formed by bilateral retouch, generally abrupt. The borer is rounded at the end, and thick in cross section. A small borer is manufactured on a blank of 5 cm. or less in length. This is a type described by Bar-Yosef (1970a:Fig. 8, no. 93), although without the emphasis on the rounded and thick profile. The mèche de foret of Tixier (1963:62, Fig. 16, nos. 13-15) falls into this category.

Large borer (Fig. B-7): The blank is a blade, bladelet, primary flake, or noncortical flake. The blank is longer than 5 cm. in length. The borer is a tip formed by bilateral retouch, generally abrupt. It

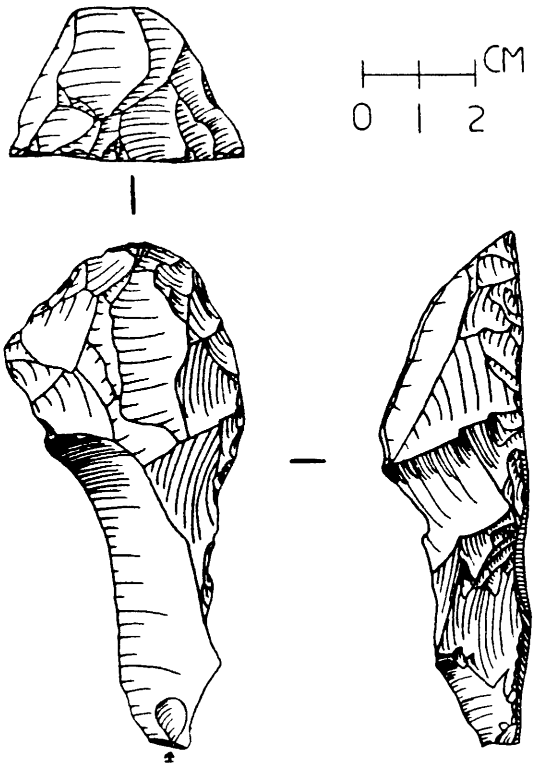


Figure B-5. Scraper/plane, Trench E, Level 306.

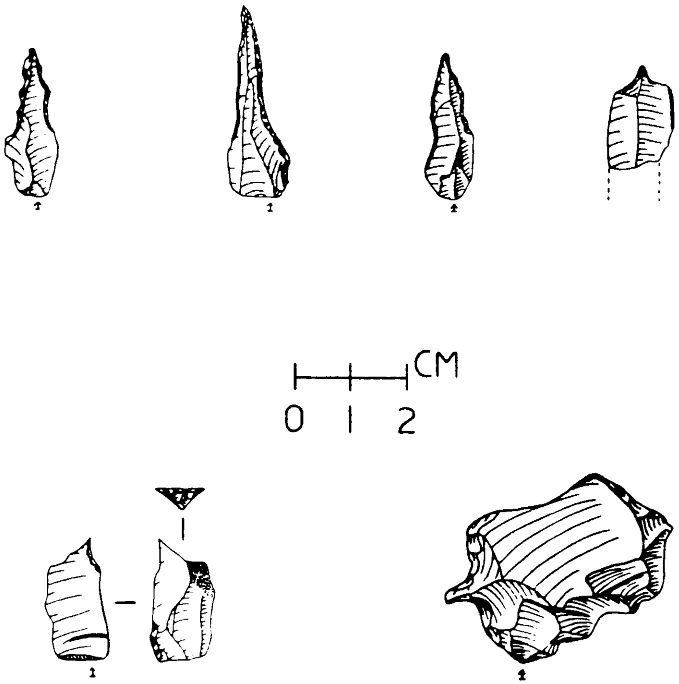


Figure B-6. Perforators, Trench E. -- a: single, L. 281; b: single, L. 294; c: single, L. 285; d: single. L. 293; e: single, L. 281, spit 1; f: single, L. 284.

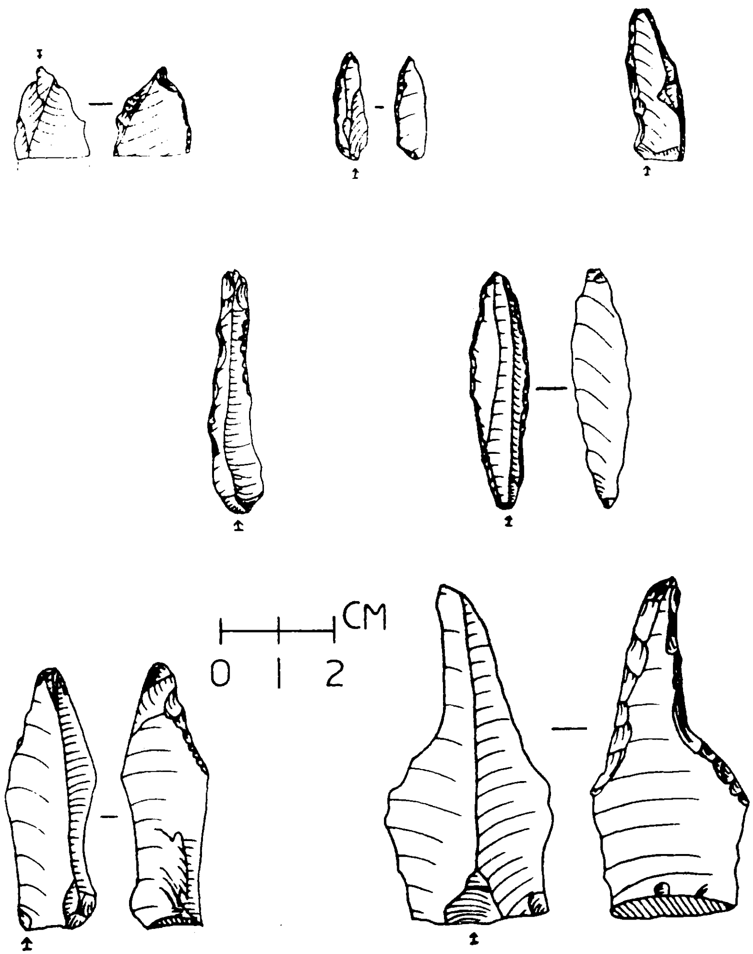


Figure B-7. Perforators and borers, Trench E. -- a: perforator on backed bladelet, L. 297; b; double perforator, L. 323; c: small borer, L. 285; d: small boreer, L. 296; e: double borer, L. 305; f: large borer, L. 294; g: lare borer, L. 285.

is rounded at the end, and thick in cross-section (derived from Bar-Yosef 1970a:Fig. 8, no. 93).

Double borer (Fig. B-7): The blank is a blade or bladelet. The borers are located opposite each other. They are formed by bilateral retouch, generally abrupt. The borers are thick in cross section, and rounded at their ends (derived from Bar-Yosef 1970a: Fig. 8, no. 93).

Burins

Dihedral burin (Fig. B-8): The blank is commonly a blade or bladelet. The burin is formed by the intersection of two burin spall removals. Almost all types of dihedral burins are collapsed into this category.

Burins on a break (Fig. B-8): The blank is usually a blade or bladelet, but can be a noncortical flake. The burin is formed by the origin of a burin spall removal from a broken edge, or by a group of removals from a broken edge (Tixier 1963:71. Fig. 19, no. 1).

Burin on a truncation (Fig. B-8): A blade or bladelet is the common blank type, but this may also be a noncortical flake. The burin is formed by the origin of a burin spall removed from a truncation, or by a group of such removals from the same area from a truncation. The truncation may be straight, oblique, concave, or convex. This represents a collapsed category of the types of Tixier (1963).

Multiple burin on a truncation (Fig. B-8): Generally, this type is on a blade or bladelet, but may also be on a noncortical flake. The burins may consist of any of the following removals: burin spall, or group of spalls, from two truncations, from both sides of the same truncation, or from two or more edges of two truncations ("Tixier 1963:77, Fig. 22, nos. 1, 2, 4, 7).

Burins on a natural edge (Fig. B-9): The blank is generally a blade or bladelet, but may be a noncortical flake. The burin is formed by the origin of a burin spall removal, or group of removals, from an unbroken edge, as opposed to a burin on a broken edge.

Burins on a striking platform (Fig. B-8): The blank may be a blade, bladelet, primary flake, or noncortical flake. The burin is formed by the origin of a burin spall, or group of spalls, from the striking platform (probably a specialized form of burins on natural edges).

Core-like burin: The blank is a noncortical flake or

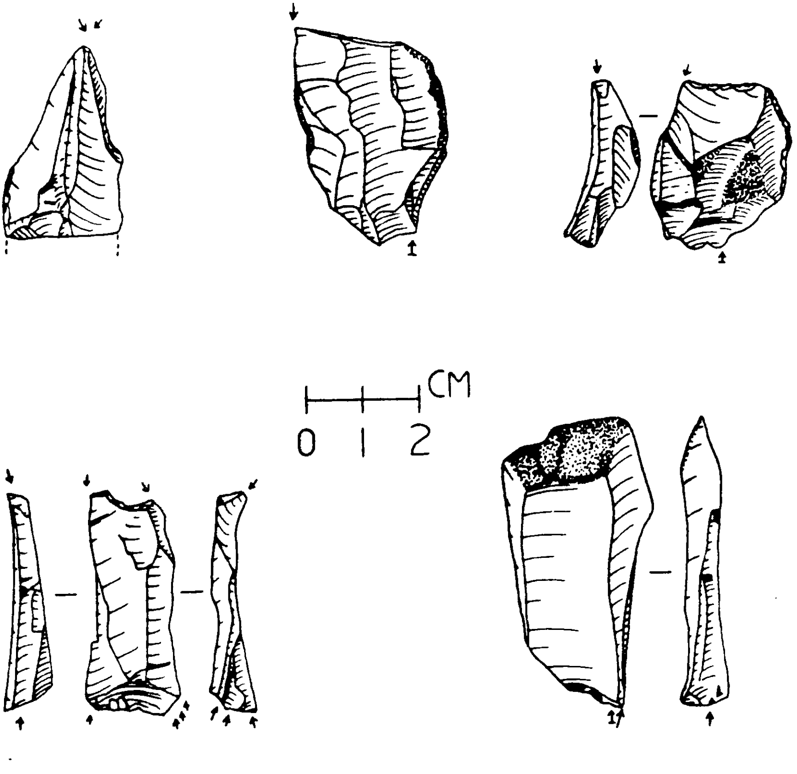


Figure B-8. Burins, Trench E. -- a: dihedral, L. 291; b: on break, L. 282; c: on truncation, L. 286; d: multiple on truncation, L, 290; e: on striking platform, L. 285.

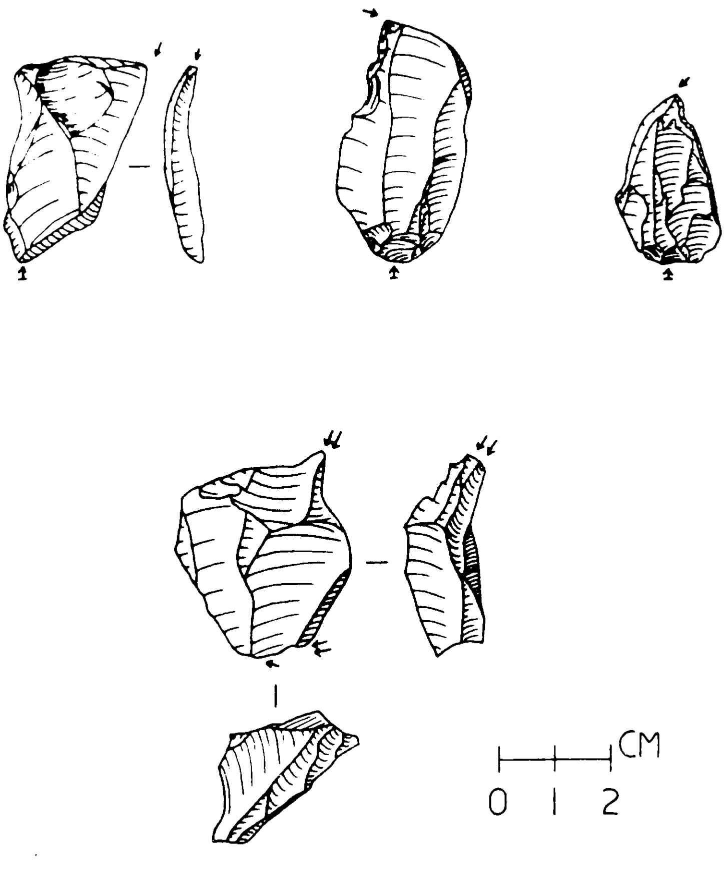


Figure B-9. Burins, Trench E. -- a: on natural edge, L. 294; b: transverse off retouched edge, L. 286; c: transverse off retouched edge, L. 293; d: multiple, L. 306.

blade. The burin generally consists of a series of bladelet/spall removals which lend the aspect of a core (Tixier 1963:79, Fig. 24).

Transverse off retouched edge (Fig. B-9): The blank can be a noncortical flake, blade or bladelet. The burin is formed by the orgin of a burin spall, or group of spalls, from a retouched edge. The retouched edge must have retouch other than the abrupt variety, or present an aspect that is not that of a backed edge.

Multiple burin (Fig. B-9): The blank is a blade, bladelet or noncortical flake. The burins are formed by a combination of two or more of the types previously described (Tixier 1963:77. Fig. 22, no. 9).

Backed Flakes and Blades

Backed flake (Fig. B-10): The blank is generally a noncortical flake, but can also be a primary flake. The retouch forming the backing is abrupt (Tixier 1963:85, Fig. 28, nos. 1-2).

Straight backed blade (Fig. B-10): The blank is a blade. The backed edge is generally abrupt, and more or less linear in form. The distal extremily is pointed, and the proximal end is not retouched (Tixier 1963:85, Fig. 28, nos. 3-5).

Blade with a convex backed tip (Fig. B-10): A blade serves as the blank. The retouch is generally abrupt. Only the distal one-third of the blade is backed along one lateral side. This has a convex form that is continuous with the remainder of the lateral edge (Tixier 1963:86, Fig. 29, nos. 4, 5).

Convex backed blade (Fig. B-10): The blank is a blade. The entire backed edge, generally formed by abrupt retouch, is convex in form (Tixier 1963:89, Fig. 31, nos. 1, 2).

Undulating backed blade (Fig. B-11): Blades are the blanks. Abrupt retouch forms the backing along the entire edge. The backed edge exhibits a convex-concave form. Tixier's convex-concave blade (1963:91, Fig. 32, no. 1) is convex for the proximal two-thirds of the tool, and concave for the distal one-third of the backing.

Partially backed blade (Fig. B-10): The blank is a blade. The backed edge may be straight or curved, but is only backed for a portion of its length. This backed area cannot be similar to the convex backed tip blade. The backing is abrupt retouch (Tixier 1963:91, Fig. 32, no. 4).

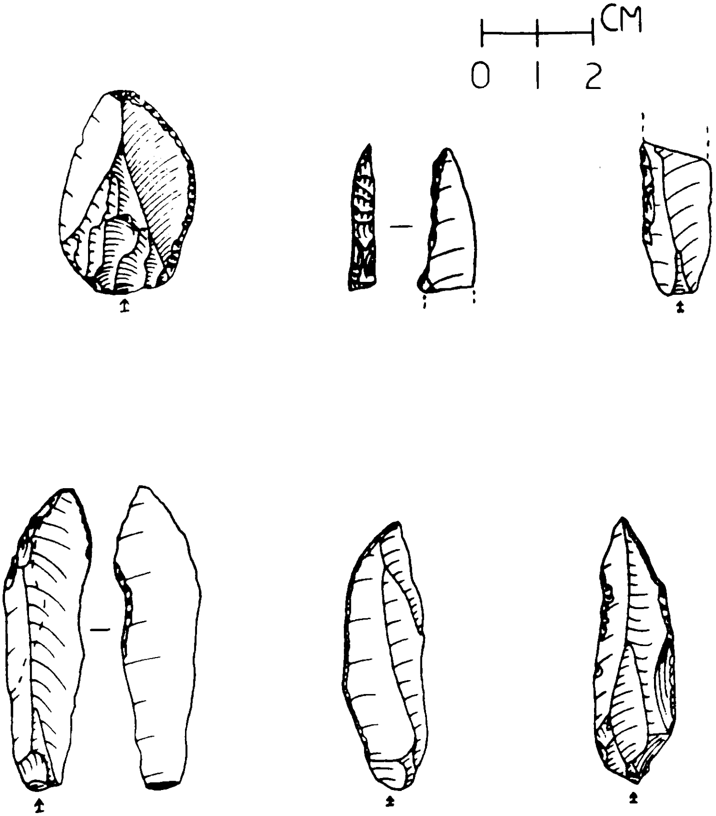


Figure B-10. Backed flake and blades, Trench E. -- a: backed flake, L. 286; b: straight backed blade, L. 282; c: partially backed blade, L. 281, spit 2; convex backed tip, L. 295; e: convex backed, L.293; f: convex backed, L. 298. Dashes indicate extent of mastic.

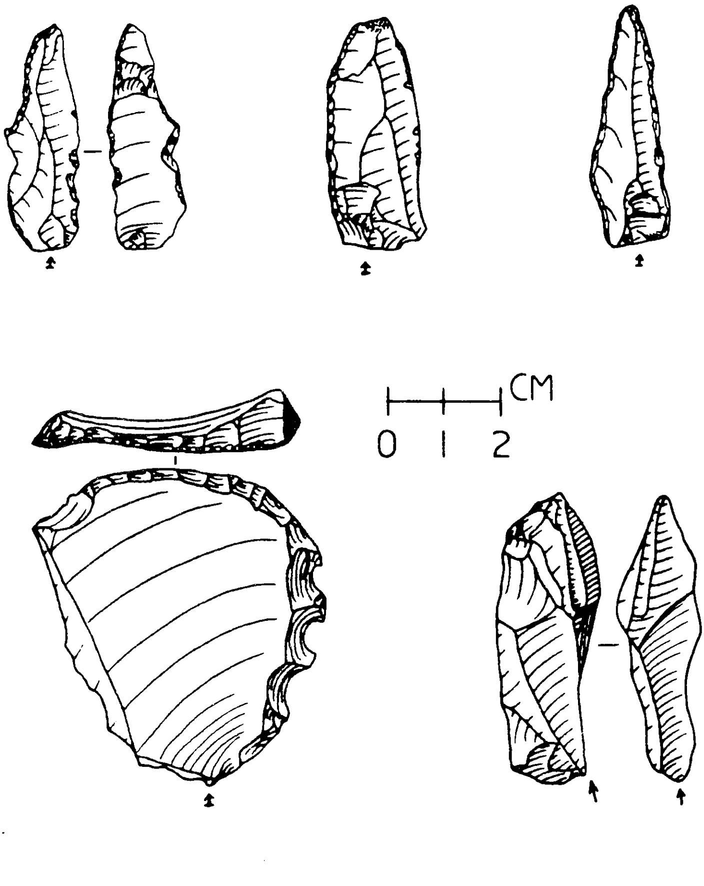


Figure B-11. Backed blades and composite tools, Trench E. -- a: undulating backed, L. 281, spit 2; b: blunt tip, L. 288; c: double backed, L. 287; d: scraper-denticulate, L. 303; e: scraper-burin, L. 282.

Backed blade with blunt tip (Fig. B-11): A blade serves as the blank type. The entire lateral edge is backed by abrupt retouch. The distal extremity is not pointed, and is not retouched (Tixier 1963:91, Fig. 32, no. 3).

Double backed blade (Fig. B-11): The blank is a blade. Both lateral edges are backed by abrupt retouch. The distal end can be either pointed or transverse.

Fragment: Blank types are blades. Backing is formed by abrupt retouch. Broken backed blades are generally too small to be diagnostic.

Composite Tools

Each type is generally rare. It is important to recognize these multiple use tools since they represent restricted combinations of tools. Blanks are usually large.

Scraper-denticulate (Fig. B-11): Blanks can be blades, bladelets, or any type of flake other than a cortical flake. One edge has been modified into a scraper. Another edge exhibits denticulation. These edges may or may not be contiguous.

Scraper-burin (Fig. B-11): Blanks are any type of flake other than cortical, or blades, or bladelets. One lateral edge is a scraper. The burin is formed by the origin of a burin spall removal(s) from a natural, broken, retouched, or truncated edge, or from other burin spall removals (Tixier 1963:93, Fig. 33, nos. 2, 4).

Burin-notch (Fig. B-12): Blank types are flakes other than cortical flakes, and blades or bladelets. The burin is formed by two or more of the following: dihedral, on break, truncation, striking platform, natural or retouched edge. The notch is either of the Clactonian or retouched variety, and may be located on any edge.

Scraper-borer/perforator (Fig. B-12): Flakes other than cortical, or blades or bladelets are the blank types. One edge serves as a scraper. Along another edge, which can be contiguous, either a perforator or a borer is manufactured. Generally, these tend to be perforators rather than borers.

Other composite tools: These are rare in the assemblage and consist of the following types: scraper-chopper, notch-sidescraper, perforator/borer-truncation (Fig. B-12), and perforator/borer-burin.

Nongeometric Microliths

Pointed straight backed bladelet (Fig. B-12): The

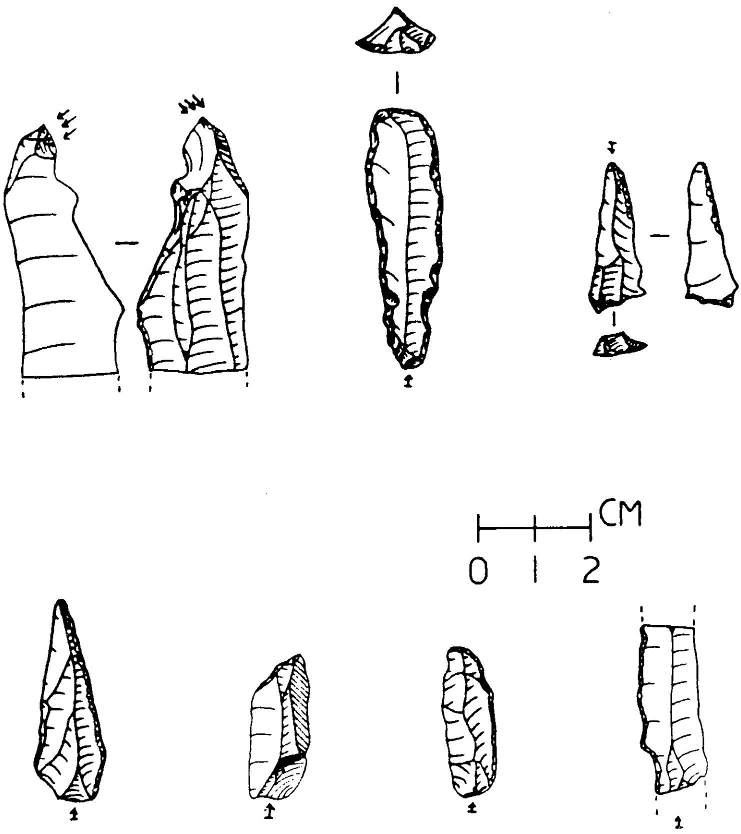


Figure B-12. Composite tools and backed bladelets, Trench E. -- a: burin-notch, L. 304; b: scraper-borer, L. 282; c: borer-truncation, L. 294; d: straight backed bladelet, L. 292; e: convex backed tip bladelet, L. 293; f: convex backed bladelet, L. 282; g: undulating backed bladelet, L. 285.

blank is a bladelet. The backed edge is usually abruptly retouched, or occasionally anvil retouched, and the backed edge is linear in appearance. The distal extremity is pointed (Tixier 1963:97, Fig. 34, nos. 1-8).

Bladelet with a convex backed tip (Fig. B-12): A bladelet serves as the blank. The retouch forming the backed end is abrupt or anvil type. Only the distal one-third of one lateral edge is backed. This has a convex form that is continuous with the remainder of the lateral edge (Tixier 1963:104, Fig. 36, nos. 1-3).

Convex backed bladelet (Fig. B-12): The blank is a bladelet. The entire backed edge, formed by abrupt or anvil retouch, is convex in form. The proximal end may be retouched (Tixier 1963:104, Fig. 36, nos. 5-12).

Undulating backed bladelet (Fig. B-12): Bladelets are the blanks. Abrupt or anvil retouch forms the backing. The backed edge exhibits an intentional gibbosity (Tixier 1963:104, Fig. 36, no. 16).

Partially backed bladelet (Fig. B-13): The blank is a bladelet. The backed edge may be straight or convex, but is only backed for a portion of its length. This backed area cannot be similar to the convex backed tip bladelet. The backing is formed by abrupt or anvil retouch (Tixier 63:111, Fig. 39, nos. 1-2).

Backed bladelet with blunt tip (Fig. B-13): A bladelet is the blank type. The entire lateral edge is backed by abrupt or anvil retouch. The distal extremity is not pointed, and is not retouched (Tixier 1963:111, Fig. 39, no.13).

Double backed bladelet (Fig. B-13): The blank type is a bladelet. Both lateral edges are backed by either abrupt or anvil retouch. The distal end can be pointed or straight.

Backed and truncated bladelet (Fig. B-13): A bladelet is the blank type. One lateral edge is backed by abrupt or anvil retouch. The distal end is truncated (Tixier 1963:111, Fig. 39, nos. 15-19).

Fragment: Blanks are bladelets. Backing is formed by abrupt or anvil retouch. The broken bladelet is too fragmentary to be diagnostic of a specific type.

Notch-Denticulate

Notched flake (Fig. B-13): The blank can be any type of flake. There are one or more nonadjacent notches. These may be Clactonian or retouched (Tixier 1963:118, Fig. 41, nos. 2, 3).

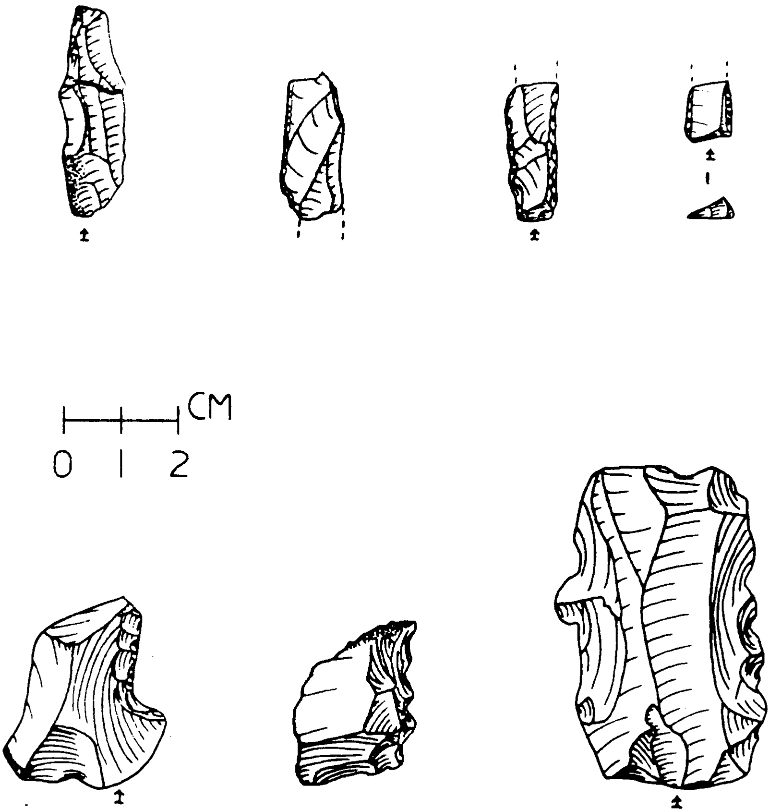


Figure B-13. Nongeometric microliths and notch-denticulates, Trench E. -- a: partially backed bladelet, L. 286; b: blunt tip bladelet, L. 285; c: double backed bladelet, L 287; d: backed and truncated bladelet, L. 282; e: notched flake, L. 288; f: denticulated flake, L. 285; g: denticulated flake, L. 304.

Denticulated flake (Fig. B-13): Any type of flake is the blank. There are three or more adjacent notches (Bordes 1979:Fig. 40, nos. 2-7).

Notched blade, bladelet (Fig. B-14): The blank is a blade or bladelet. There are one or more nonadjacent notches (Tixier 1963:122, Fig. 43, nos. 2, 3).

Denticulated blade, bladelet (Fig. B-14): A blade or bladelet is the blank. There are three or more adjacent notches (Bordes 1979: Fig. 40, nos. 2-7).

Truncations

Truncation (Fig. B-14): The blank is a primary flake, noncortical flake, blade or bladelet. Either or both the proximal and distal ends are retouched. This retouched edge forms an angle with both the lateral edges. The truncation can be straight, oblique, convex or concave (Tixier 1963:126, Fig. 46, nos. 2, 3).

Geometric Microliths

Lunate (Figs. B-15, 16, 17): The blank is a bladelet. The lunate is a geometric microlith having the outline of a semi-circle. The backing is formed by abrupt or anvil retouch. The nonretouched edge is more or less linear (Tixier 1963:130, Fig. 47, nos. 2, 3).

Isosceles trapeze (Fig. B-17): A bladelet is the blank type. The proximal and distal ends are retouched by abrupt or anvil retouch. One of the lateral edges may be retouched by abrupt or anvil retouch. The lateral edges are linear, and the distal and proximal ends are angled toward the longer and nonretouched lateral edge. The Tixier definition (Tixier 1963:130, Fig. 47, nos. 4, 5, 7, 8) has both lateral edges nonretouched. Bar-Yosef (1970a:Fig. 8, no. 76) allows retouch on the short lateral edge.

Other trapeze: These include various asymmetrical forms (Fig. B-17), forms with concave retouched edges, and unfinished trapezes.

Trapeze-rectangle (Fig. B-17): The blank is a bladelet. Either the distal or the proximal truncation is perpendicular to the lateral sides. The remaining truncation is angled. The short lateral edge can be retouched.

Isosceles triangle (Fig. B-18): A bladelet is the blank. The two retouched sides are equal in length (Tixier 1963:133, Fig. 48, nos. 2-4).

Scalene triangle (Fig. B-18): A bladelet is the blank. The two retouched sides are unequal in length with each and with the base (Tixier 1963:133, Fig. 48, no. 6).

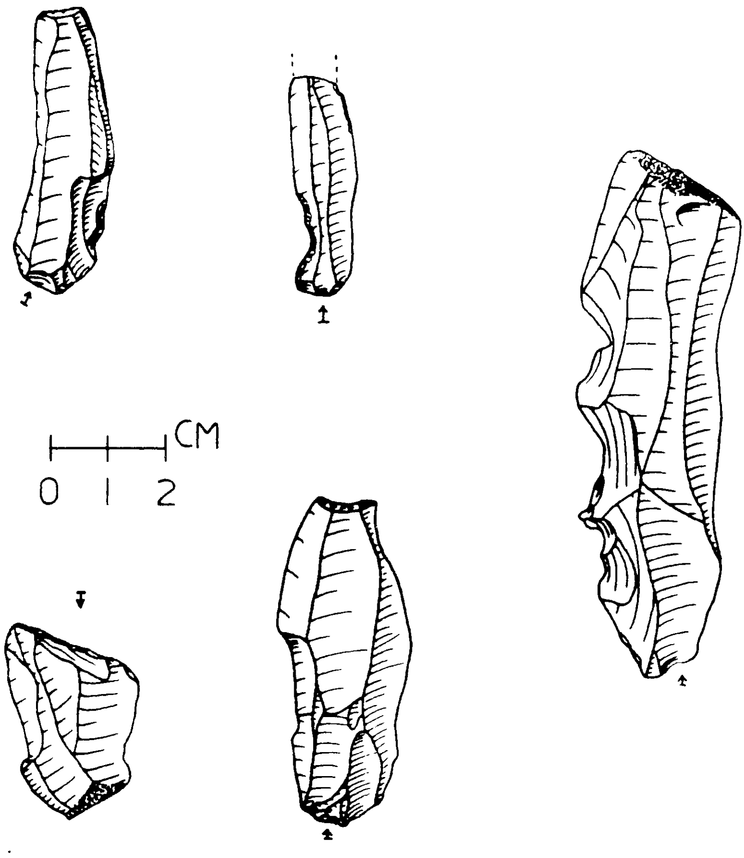


Figure B-14. Notch-denticulates and truncations, Trench E. -- a: notched blade, L. 304; b: notched bladelet, L. 285; c: denticulated blade, L. 294; d: oblique truncation, L. 290; e: concave truncation, L. 297.

Figure B-15. Lunates, Trench E. -- Dashed line refers to extent of mastic; dotted line refers to polish.

a. L. 311, intact tips, abrupt retouch, mastic.

b. L. 324, intact tips, anvil retouch, polish, mastic.

c. L. 305, intact tips, abrupt retouch.

d. L. 305, intact tips, abrupt retouch, notched modifcation.

e. L. 305, intact tips, abrupt retouch.

f. L. 305, intact tips, anvil retouch, flat invasive retouch.

g. L. 305, broken tip, anvil retouch, nibbling modification.

h. L. 280, broken tip, fine retouch, nibbling modification.

i. L. 290, broken tip, fine retouch.

j. L. 290, striking platform, fine retouch, nibbling modification.

k. L. 280, intact tips, anvil retouch.

l. L. 281, spit 1, broken tip, alternate abrupt.

m. L. 271, spit 2, intact tips, alternate abrupt. notched modification.

n. L. 323, broken tip, fine retouch, mastic.

o. L. 323, burina tip, abrupt retouch, denticulated modification, polish, mastic.

p. L. 310, broken tip, anvil retouch, nibbling modification.

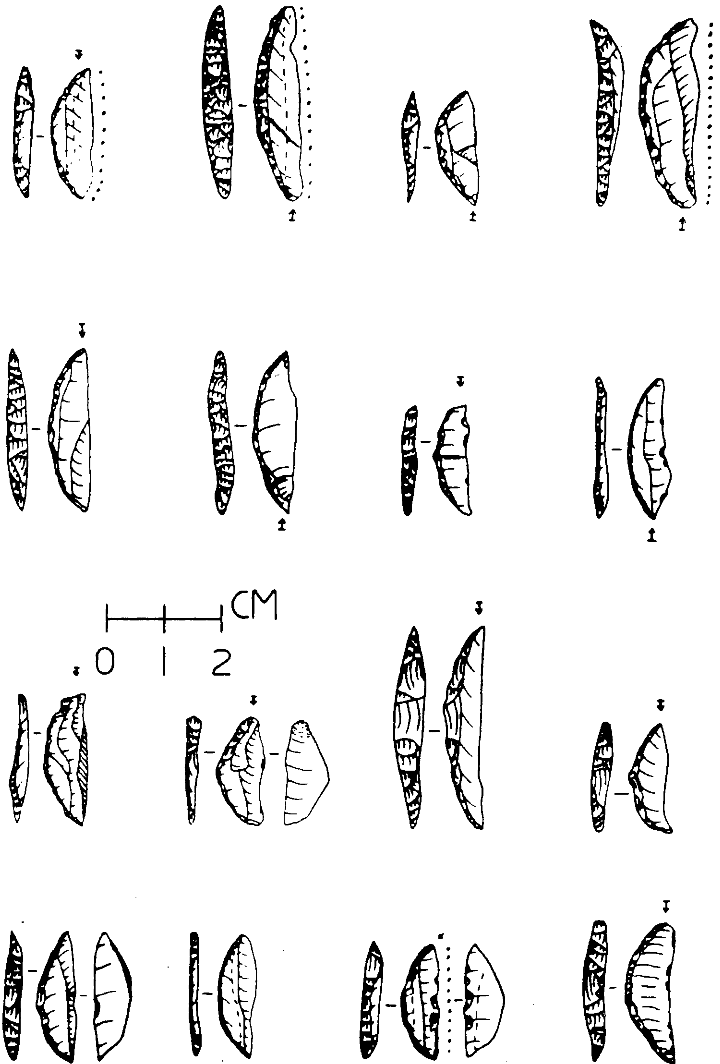


Figure B-15. Lunates, Trench E.

Figure B-16. Lunates, Trench E.

a. L. 310, burinated tip, fine retouch.

b. L. 304, broken tips, abrupt retouch, nibbling modification.

c. L. 293, perforator tip, abrupt retouch.

d. L. 308, perforator tip, aburpt retouch.

e. L. 308, reworked tip, abrupt retouch, nibbling modification.

f. L. 296, perforator tip, abrupt retouch.

g. L. 265, perforator tip, abrupt retouch, denticulated modification.

h. L. 292, burinated tip, abrupt retouch.

i. L. 292, burinated tip, abrupt retouch, fine modification.

j. L. 297, burinated tip, anvil retouch.

k. L. 284, reworked tip, abrupt retouch, nibbling modification.

l. L. 326, broken tip, abrupt retouch.

m. L. 253, reworked tip, abrupt retouch, fine modification.

n. L. 253, broken tip, abrupt retouch, notched modification.

o. L. 286, intact tips, abrupt retouch.

p. L. 288, broken tips, anvil retouch.

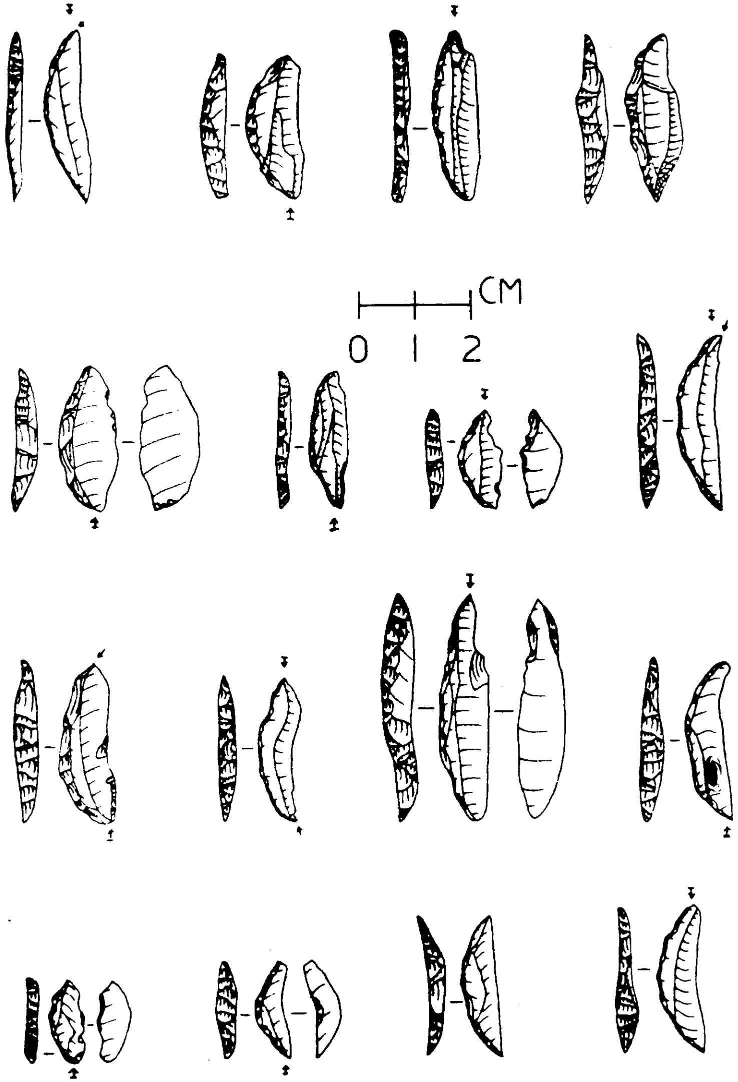


Figure B-16. Lunates, Trench E.

Figure B-17. Lunates and other geometric micorliths, Trench E. -- Dashed line refers to extent of mastic.

a. L. 297, intact tips, nibbling modification.

b. L. 281, spit 2, burinated tip, abrupt retouch, nibbling modification.

c. L. 298, broken tips, abrupt retouch, noted modification.

d. L. 300, intact tips, abrupt retouch, abrupt modification.

e. L. 286, broken tip, abrupt retouch, fine modification, polish, mastic.

f. L. 285, broken tip, abrupt retouch, flat invasive modifiction.

g. L. 299, broken tip, abrupt retouch, denticulated modification.

h. L. 282, intact tips, anvil retouch, flat invasive modification.

i. L. 303, reworked tip, abrupt retouch, fine modification.

j. L. 298, intact tips, abrupt retouch, flat invasive modification.

k. L. 305, trapeze/rectangle.

l. L. 285, broken tip, anvil retouch, nibbling modification.

m. L. 324 spit 2, broken tip, abrupt retouch, notched modification.

n. L. 305, isosceles trapeze.

o. L. 288, asymmetrical trapeze.

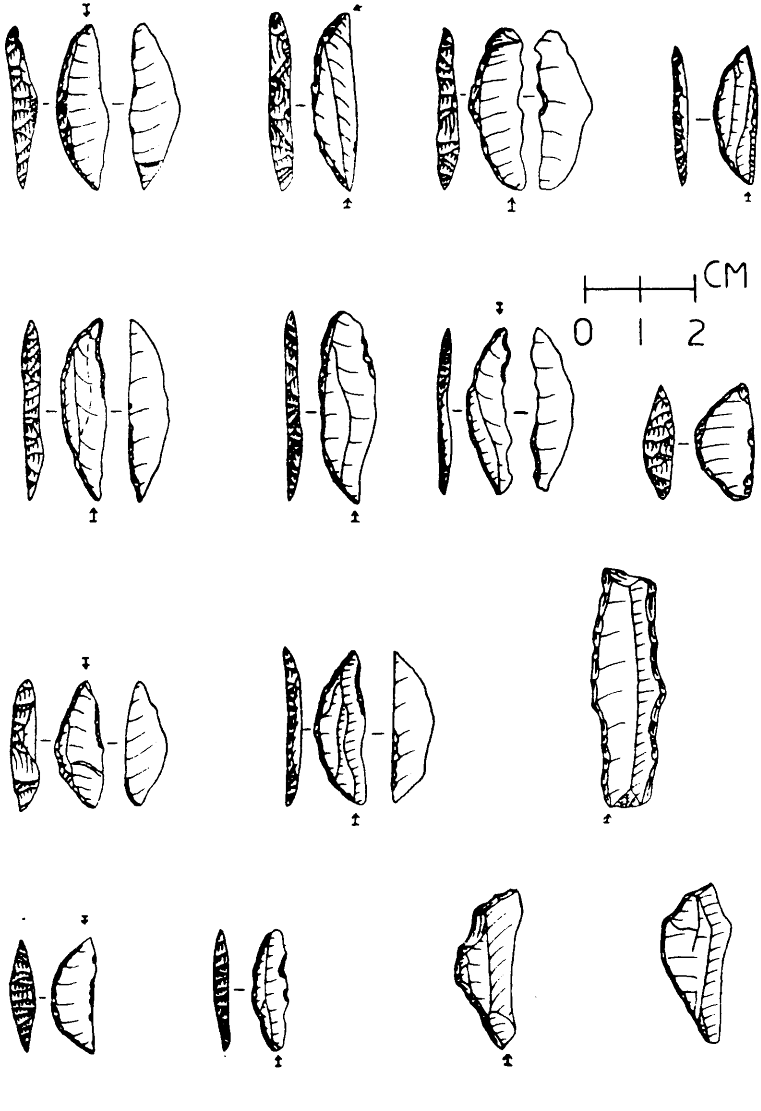


Figure B-17. Lunates and other geometric microliths, Trench E.

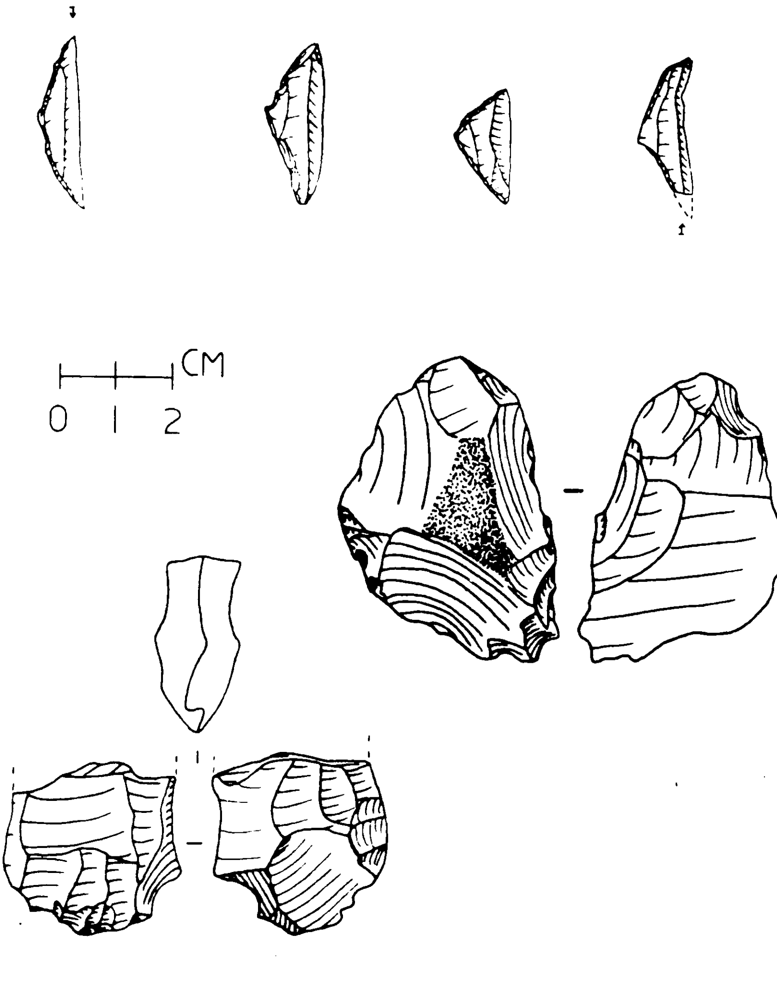


Figure B-18. Geometric microlithis and bifaces, Trench E. -- a: isosceles triangle, L. 298; b: isosceles triangle, L. 285; c: scalene triangle, L. 288; d: triangle with one convave side, L. 295; e: unfinished biface, L. 296; f: broken biface, L. 306.

Other triangle: This includes triangles with concave sides (Fig. B-18), convex sides, unfinished triangles, and triangle fragments.

Heavy tools

The blank is most often a chert nodule. Gouges, blunted, axes, and fragments appear to be more common in northern Syria, and thus are not defined in the Tixier or Bar-Yosef typologies.

Gouge (proto-erminette) (Figs. B-19, 20, 21): This is the probable forerunner of the erminette described by J. Cauvin (1978:89). However, its form is less defined than the erminette. The gouge generally has a series of short and long retouch flakes removed from one end. A large tranchet shapening flake or two has been struck from this end on the side opposite the retouch, and parallel to the long axis of the nodule. The butt end can be cortical (unretouched). The lateral edges often show extensive flake removal and battering. The cross-section is very thick at midpoint. Unlike the later erminette, the gouge end does not flare out.

Axe (Figs. B-22, 23, 24): Unlike the gouge the retouched end is formed by a small number of tranchet sharpening flakes (generallly two to three) struck parallel to the long axis of the tool. These sharpening flakes are bifacial. The butt end can be cortical or retouched. The lateral edges of the tool often show extensive flaking and battering. This type of heavy tool is thick in cross-section.

blunted (Figs. B-25, 26, 27): The blunted implements has a working edge that has been extensively flaked and reworked, so that it has a thick, blunted appearance.

fragment: These are the undiagnostic nonworking edges of gouges, axes, and blunted types. Occasionally a midsection of one of these heavy tools occurs.

Biface (Fig. B-18): The blank is generally a large and thick flake. The piece has been bifacially retouched. The retouch is such that these tools cannot be considered cores.

Chopper (Fig. B-28): Generally, the blank is a nodule, occasionally a core. The retouch forming the chopper edge can be chopper or chopper tool, and produces a sinuous edge.

Battered piece: The blank is a cortical flake, primary flake, noncortical flake, blade or bladelet. One or both lateral edges have evidence of heavy use,

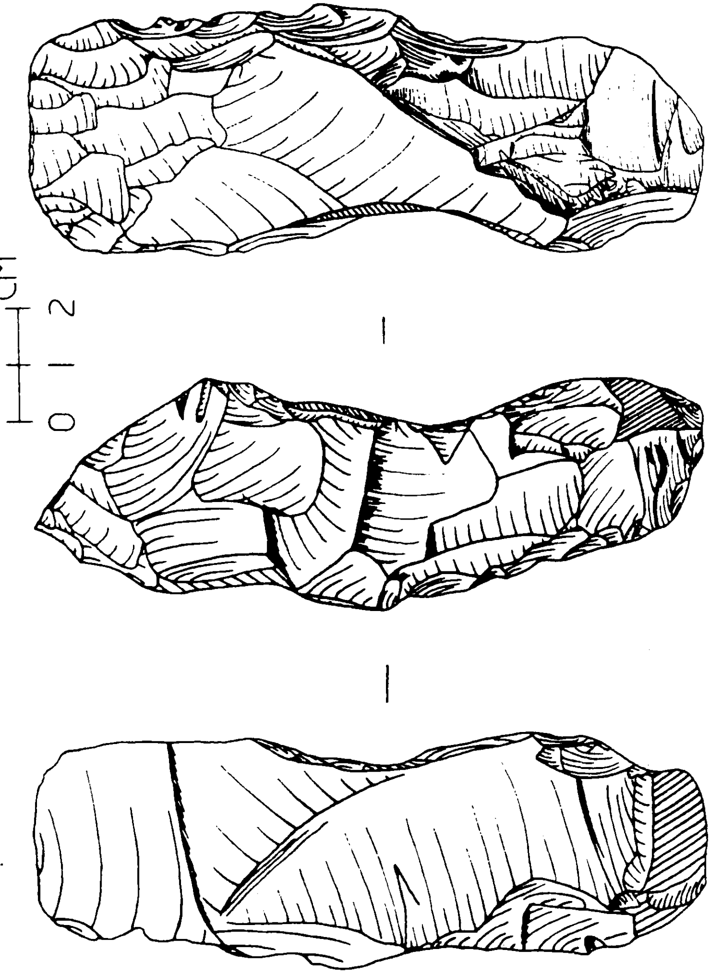


Figure B-19. Gouge, Trench E, L. 302.

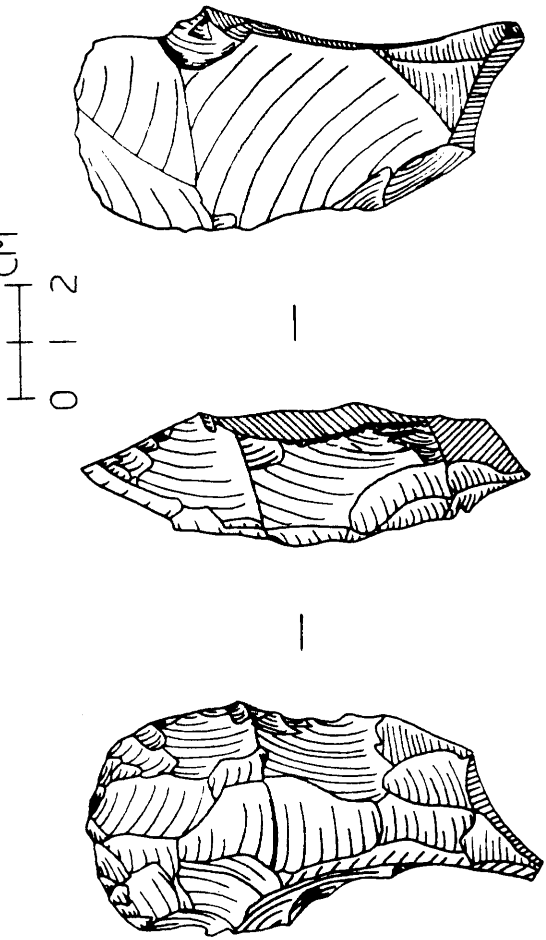


Figure B-20. Gouge, Trench E, L. 289.

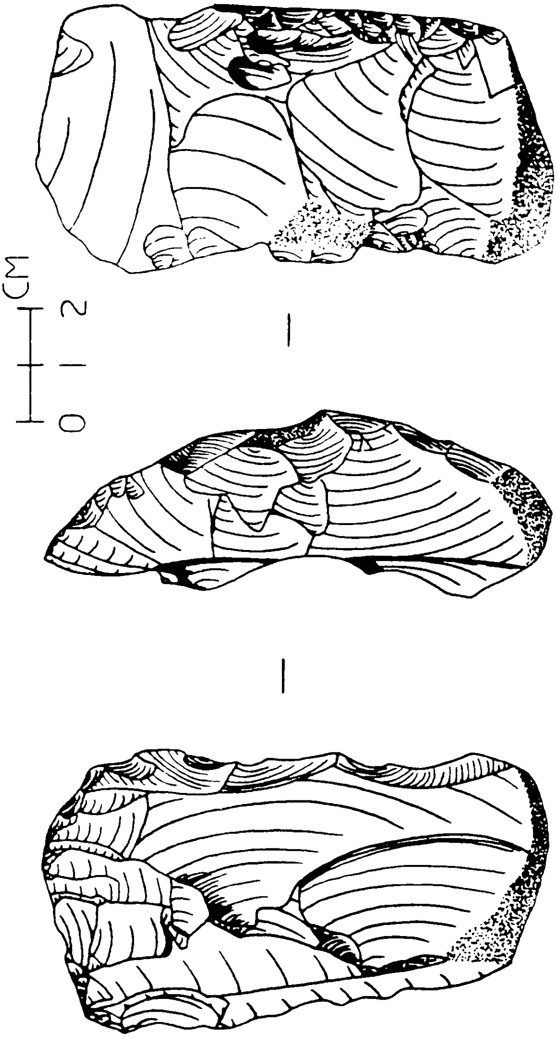


Figure B-21. Gouge, Trench E, L. 296.

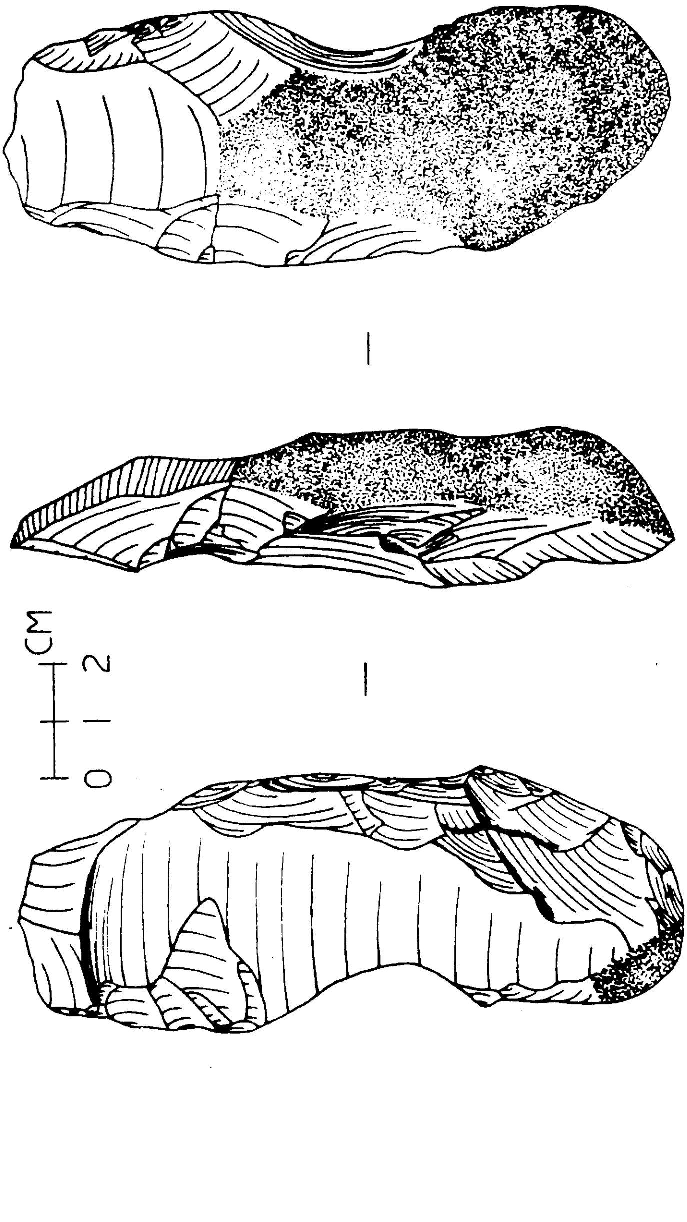


Figure B-22. Axe, Trench E, L. 297.

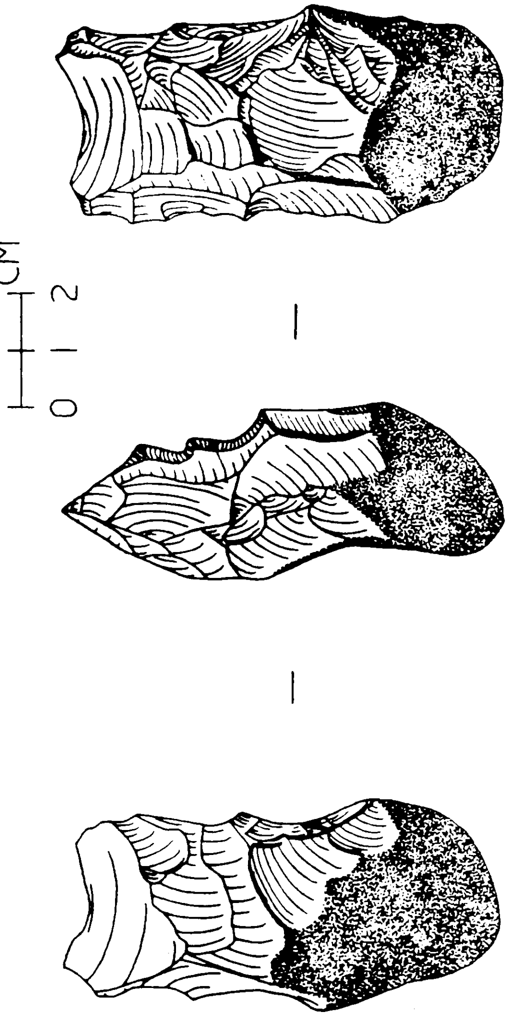


Figure B-23. Axe, Trench E, L. 289.

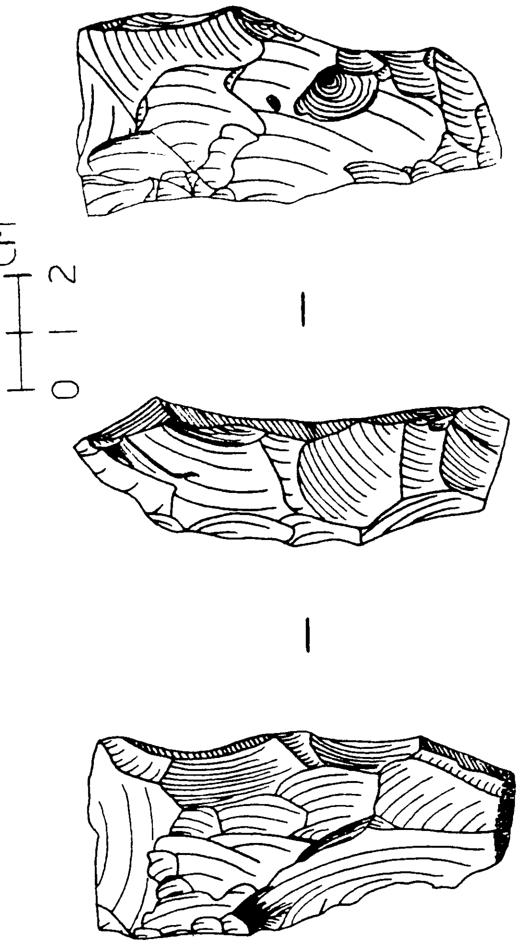


Figure B-24. Axe, Trench E, L, 294.

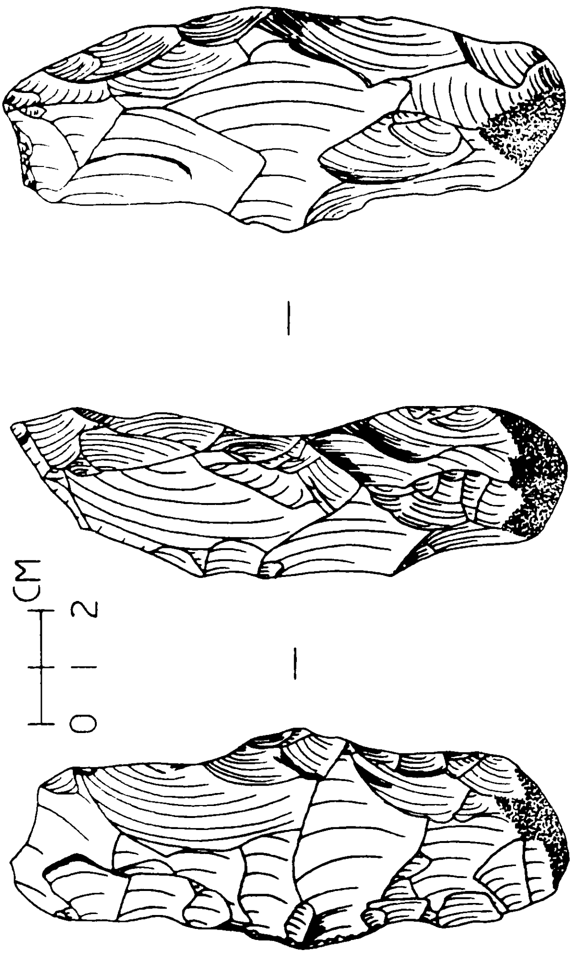


Figure B-25. Blunted, Trench E, L. 301.

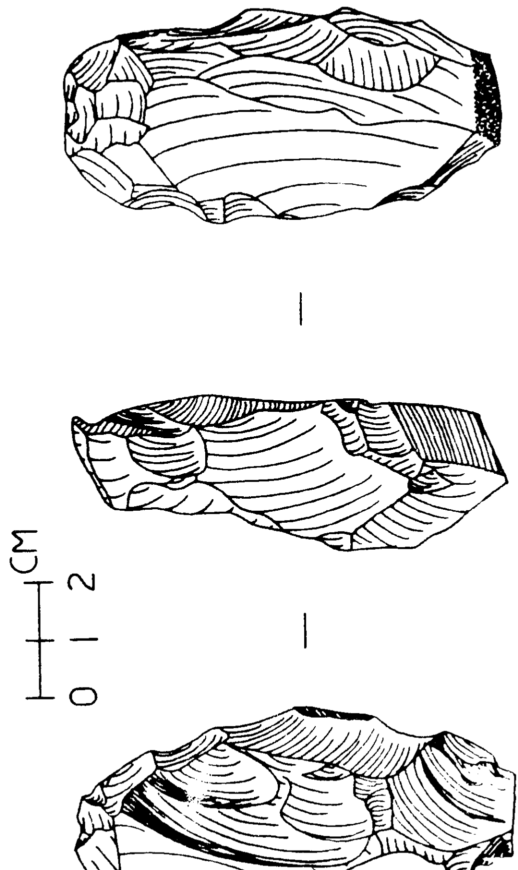


Figure B-26. Blunted, Trench E, L. 285.

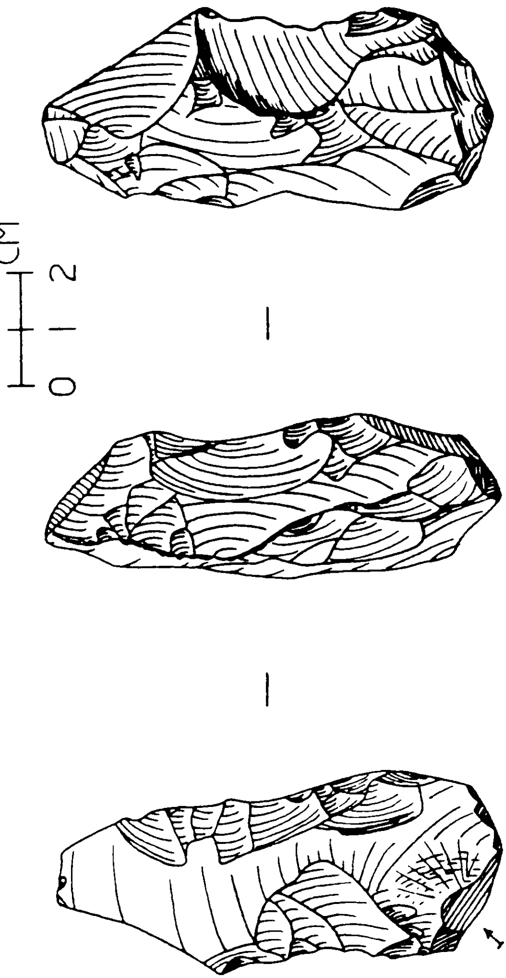


Figure B-27. Blunted, Trench E, L. 298.

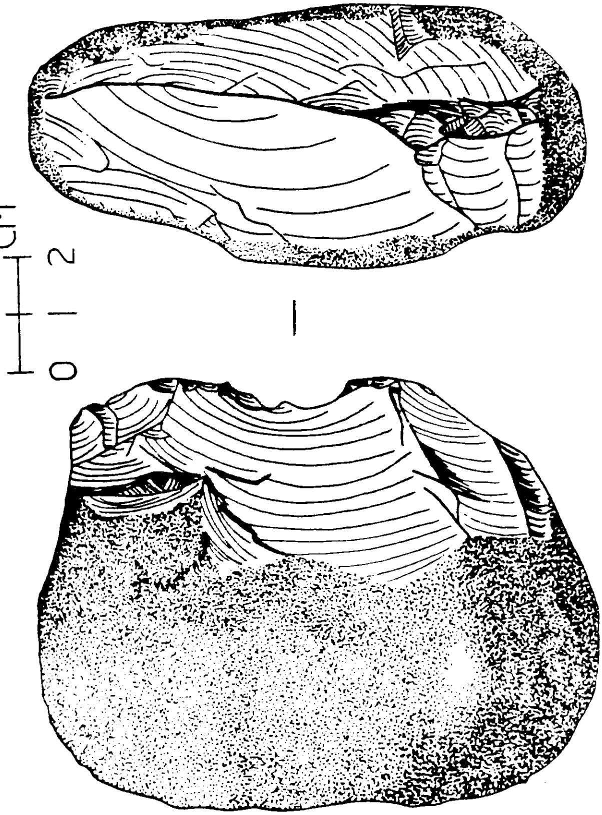


Figure B-28. Chopping tool, Trench E, L. 293.

generally an irregular retouch that can be unifacial or bifacial (Marks 1976:381).

Retouched Pieces

Retouched flake (Fig. B-29): The blank type can be a primary flake, noncortical flake, or core trimming flake. The retouch is semisteep, bifacial, or fine. The retouch is locally continuous.

Retouched blade (Fig. B-29): The blank is a blade. The retouch is semi-steep, bifacial or fine.

Retouched bladelet (Fig. B-29): A bladelet is the blank. The retouch, which can be semi-steep, bifacial or fine, is locally continuous.

Various

Sidescraper (Fig. B-30); The blank can be a blade, primary flake, or noncortical flake. One or both lateral edges are retouched with semi-steep retouch.

Naturally backed knife: The blank can be a blade, primary flake, or noncortical flake. One lateral edge is noncortical and unretouched. The opposing lateral edge is blunt and cortical (Bordes 1979:Fig. 37, nos. 13-15).

Backed pieces (Fig. B-29): The blank is a noncortical flake in most cases, but occasionally is also a blade or bladelet. Unkike backed flakes, which are backed along only one lateral edge, backed pieces are backed by abrupt retouch along all or most of all edges.

Neolithic arrowhead (Fig. B-29): The blank is a blade. The blade can be either naturally pointed or retouche into a point. The base has been retouched into a tang. These are assumed to be intrusive elements in the late Epipaleolithic at Tell Abu Hureyra.

Debitage

Flakes

Cortical: The entire exterior surface is cortical. When this blank type is used as a tool blank, the only noncortical areas are the retouch scars.

With some cortex: The exterior surface is cortical over 10%-99% of its surface.

Noncortical: The exterior surface is less than 10% cortical.

Core rejuvenation: Flakes which have evidence of previous core preparation (Marks 1976:375).

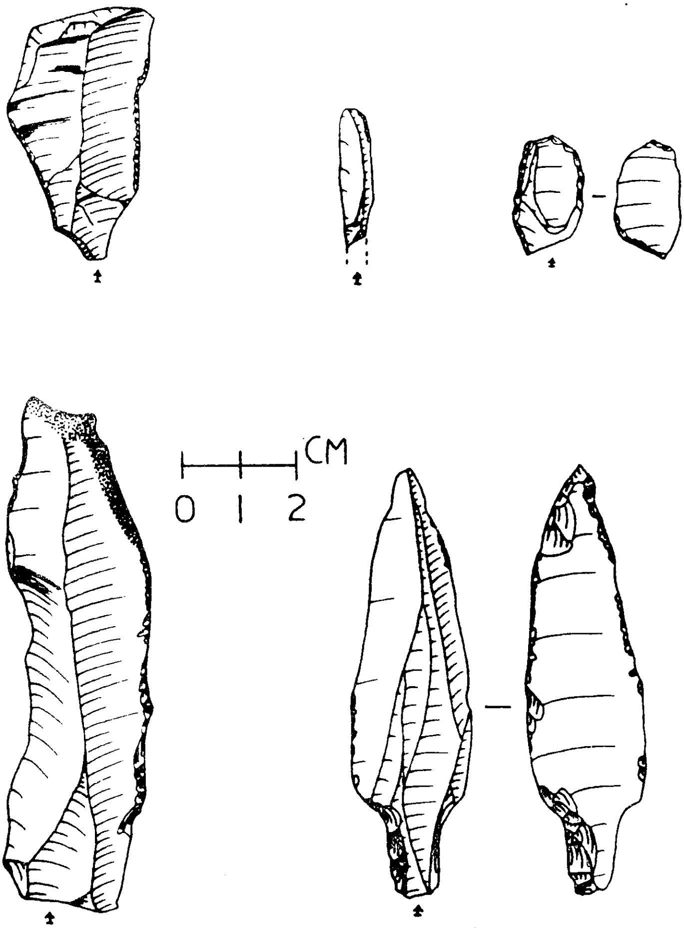


Figure B-29. Retouched pieces and Neolithic arrowhead, Trench E. -- a: retouched flake, L. 295; b: retouched bladelet, L. 301; c: backed piece, L. 293; d: retouched blade, L. 301; e: Neolithic arrowhead, L. 292.

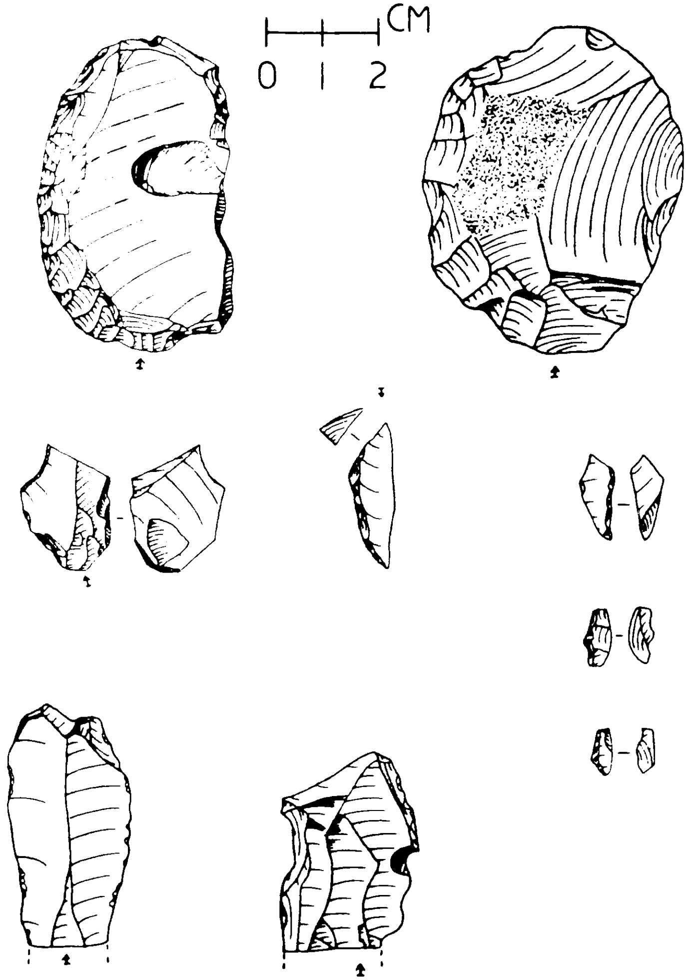


Figure B-30. Sidescrapers and debitage, Trench E. -- a: sidescraper, L. 301; b: sidescraper, L. 280; c: microburin, L. 306; d: trihedtral microburin, L. 285; e: Krukowski microburins, L. 281; f: nibbled piece, L. 287; g: nibbled piece, L. 288.

Retouch flakes: Small flakes measuring 15 mm. and less in length, generally the product of retouching and resharpening of tools.

Blades

A blade is a specialized form of a flake that has parallel leteral sides. These sides generally forom a 90 degree angle with the striking platform area. A blade is usually longer than 5 cm.

Cortical: The exterior surface is entirely cortical.

Single crest: The cross-section is triangular. This blade can be partially cortical.

Multiple crest: The cross-section is trapezoidal or multi-angled. This blade is noncortical.

Rejuvenation: The exterior surface exhibits previous core preparation.

Bladelets

A bladelet is distinguished from a blade by having a length less than 5 cm. and width less than 12 mm. (Tixier 1963:38).

Cortical: The exterior surface is completely cortical.

Single crest: The cross-section is traingular. Part of the exterior surface can be cortical.

Multiple crest: The cross-section is trapezoidal or multi-angled. The exterior surface is noncortical.

Rejuvenation: The exterior surface shows evidence of previous core preparation.

Burin spall

The part of a flake, blade or bladelet that has been detached by the burin blow technique in the formation of a burin bit (Tixier 1963:29).

Microburins

Microburins (Fig. B-30): A special technique of fracture to produce blanks for microlithic tools. This consists of manufacturing a notch along one lateral edge of a blade or bladelet. The blade or bladelet is then snapped at the notch. The part having a protion of the notch, and showing a characteristic snap scar originating at the notch and running along the interior to the opposite lateral edge, so that a point forms, is the microburin (Tixier 1963:41).

Trihedral microburin (Fig. B-30). This is the piquant triedre of Tixier (1963:137), defined as a bladelet with a microburin fracture that extends from the notch along the exterior side to the opposing lateral edge. A point is thus formed by the intersection of the microburin fracture and unretouched edge.

Krukowski microburin (Fig. B-30). A fracture scar is formed by snapping a backed bladelet so that a point is formed by the intersection of the backed edge and the snap. This type of microburin is generally considered accidental.

Pieces showing nibbling (Fig> B-30)

Blank types are blades, bladelets or any type of flake. The nibbling is an irregular retouch that may or may not be cultural in origin. The irregular nature of the retouch is such that these pieces are not formalized tools, and may not be tools at all. They are separated out to indicate that they do exist, but the interpretation of their use or classification is still open.

Debris

This is a residual category of material resulting from flaking. The pieces are irregular, fragmentary, unsuitable for tool blanks, and range in size from small to large.

Hammerstones

Generally a nodule in form, but they may also be cores. Flakes are rarely used as hammerstones. The surface exhibits battering resulting from use against another object of chert of flint.

Cores

Single platform, simple (Fig. B-31, B-32). Flakes or bladelets or blades are removed from one plane of origin in one direction from one face of a nodule. There may or may not be a prepared platform from which to strike the blanks.

Single platform, subprismatic (Fig. B-33). This type is rarely other than a core for blades and bladelets. There is a single platform from which blades or bladelets are struck in one direction along most of the circumference of the nodule. The core often has a cylindrical shape.

Single platform, subpyramidal (Fig. B-33). Can be a core for flake, blade or bladelet manufacture. Like the subprismatic core, there is a single platform. The removals occur from about three-quarters of the platform circumference, giving the core a short, roughly conical shape.

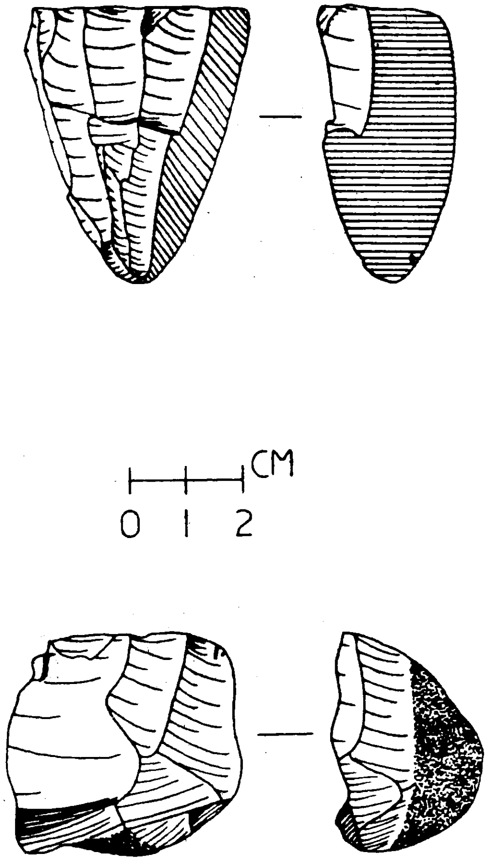


Figure B-31. Single platforam cores, Trench E. -- a: Level 285; b: Level 305.

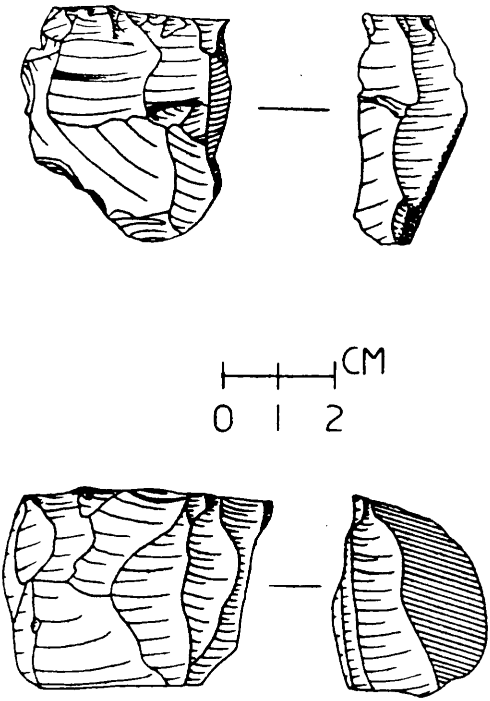


Figure B-32. Single platform cores, Trench E. -- a: Level 281, spit 1; b: Level 286.

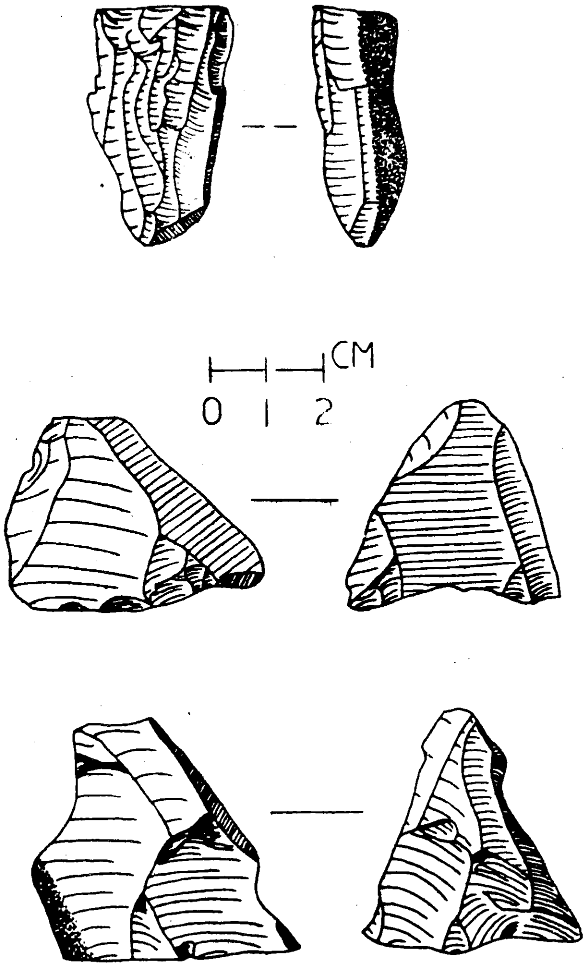


Figure B-33. Subprismatic and subpyramidal cores, Trench E. -- a: single face, subprismatic, L. 296; b: single face, subpyramidal, L. 305; c: single face, subpyramidal, L. 281.

Single platforms, adjacent faces (Fig. B-34). Flakes, blades or bladelets are removed from two faces of the nodule. The core platform for these removals is the same. Cores classified as chopping tools are included here.

Two platforms, perpendicular (Fig. B-34). Flakes, blades, or bladelets are removed from two faces of a nodule. The direction of removal from one platform is perpendicular to the second. The two platforms can occur on the same face of the nodule.

Opposed platforms and faces (Fig. B-35). Generally a core for blades or bladelets. The platforms are opposing, but located on opposite faces of the nodule.

Opposed platforms, single face (Fig. B-35). These are usually cores for blades or bladelets. There are two platforms at opposite ends of the nodule, on the same face.

Subdiscoidal (Fig. B-36). Generally a core for flake manufacture. The flake removal occur bifacially along three-quarters of the edge, giving the core the appearance of a disc.

Polyhedral (Figs. B-36, B-37, B-38). Always a core for flake manufacture. Flakes have been struck from multiple platforms on all sides of the nodule. The core has a roughly round or globular appearance.

Rejected core (Fig. B-38). A nodule from which only one removal has been made. Can be considered a test of raw material.

Core fragment. A broken core that is not classified as to type.

Retouch Types

Abrupt

Removals made either from the interior or from the exterior surface, at right angles to the interior or exterior surfaces. Generally used as a form of backing.

Anvil

Removals made from both the interior and exterior surfaces at a right angle. They are probably the result of hard hammer percussion along one edge while the other is held against an anvil. Generally a form of backing.

Bifacial

Removals are flat and generally parallel, and invade both surfaces of the blank from the same lateral edge.

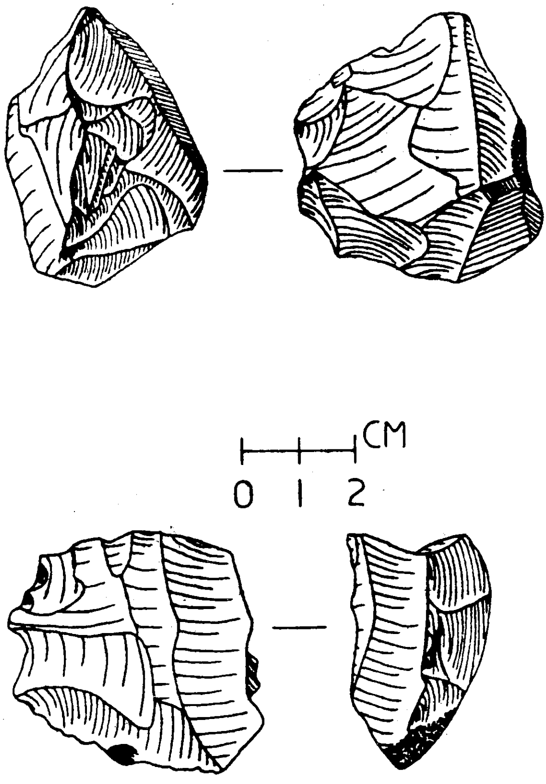


Figure B-34. Single and two platform cores, Trench E. -- a: single platform, adjacent faces, L. 281, spit 2; b: two platforms, perpendicular, L. 281, spit 1.

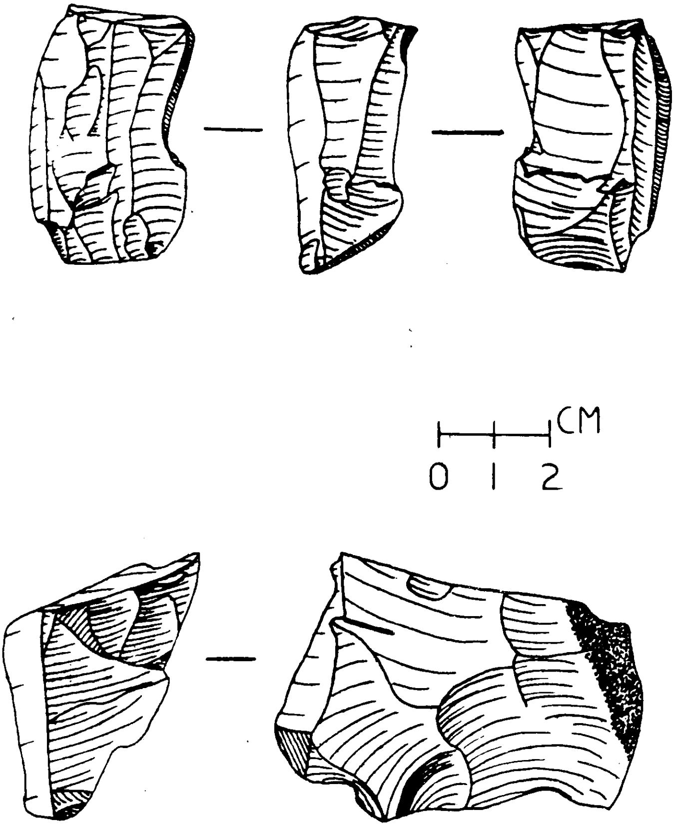


Figure B-35. Two platform cores, Trench E. -- a: opposed platforms and faces, L. 281, spit 1; b: opposed platforms, single face, L. 307.

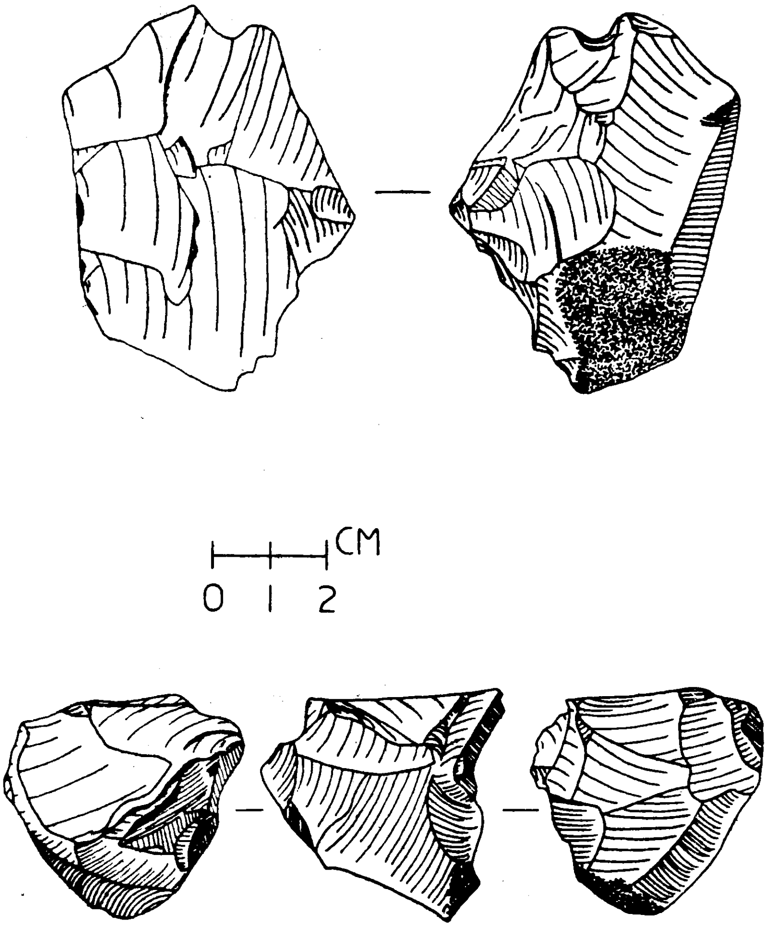


Figure B-36. Subdiscoidal and polyhedral cores, Trench E. -- a: subdiscoidal, L. 284; b; polyhedral, L. 281, spit 2.

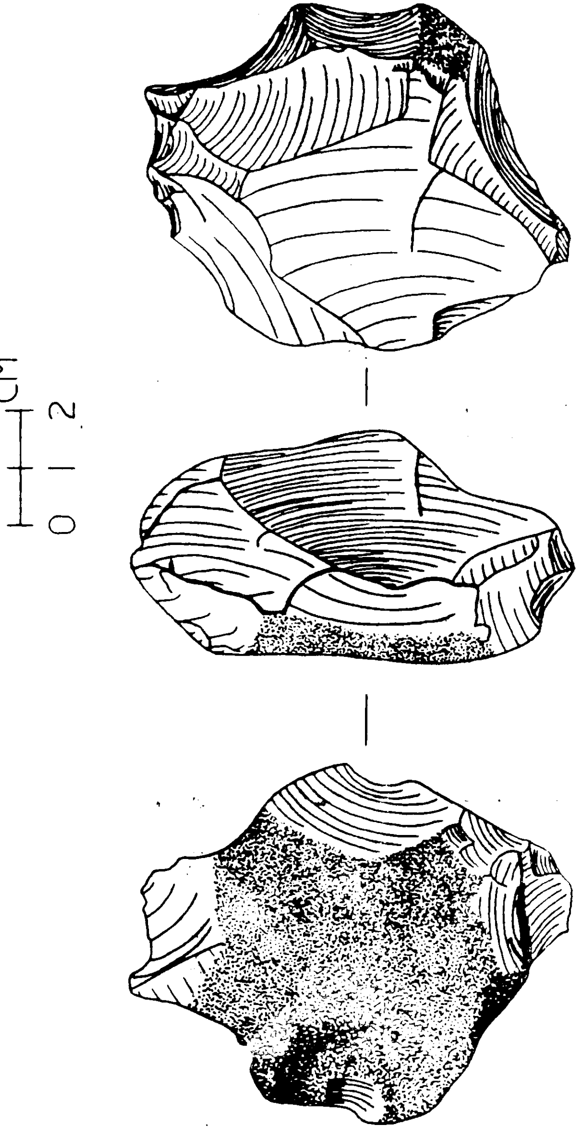


Figure B-37. Polyhedral core, Trench E, Level 281.

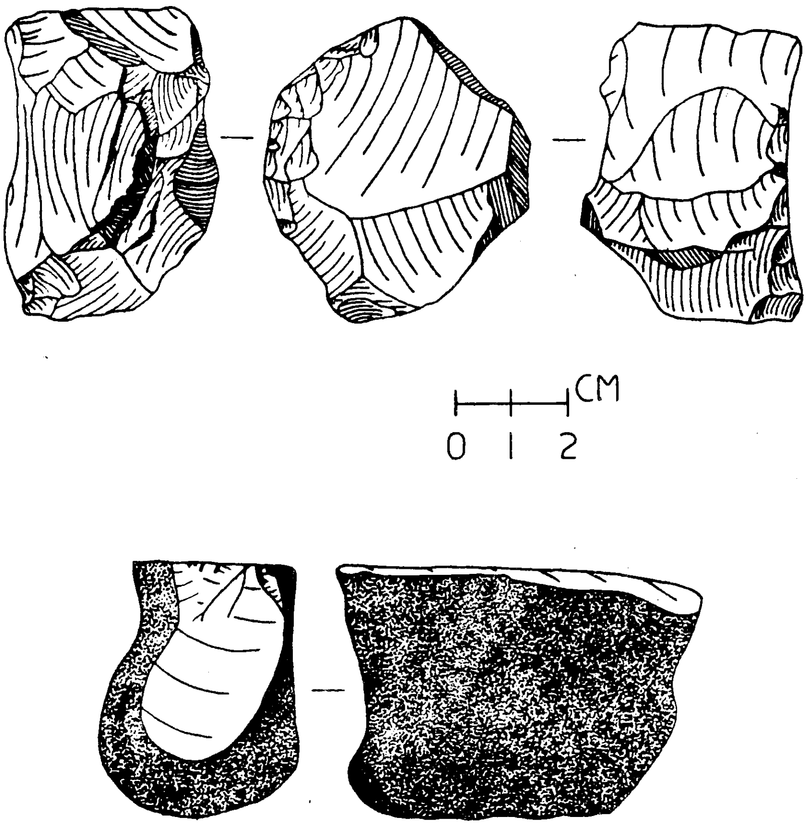


Figure B-38. Polyhedral and rejected core, Trench E. -- a: polyhedral, L. 281, spit 2; b: rejected core, L. 287.

Fine

Removals are very small in nature, and are not very invasive. May be compared to Ouchtata retouch of Tixier (1963:48).

Denticulated

Removals are three or more adjacent notches.

Helwan

Removals are steeply bifacial, resulting in a ridged form of backing. Used in an Epipaleolithic context only on lunates, sickle blades, and certain nongeometric microliths.

Invasive

Removals are flat, generally parallel, and penetrate more deeply across the surface than other forms of retouch. They invade the surface of the blank at an angle of less than 30 degrees.

Nibbling

Removals are irregular, short, and small. May or may not be cultural in origin.

Notched

Removal is one or more nonadjacent notches. May be of the Clactonian (Bordes 1979:Fig. 39, no. 8) or multiple flaked varieties. A Clactonian notch is a single blow removal. The multiple flaked notch is formed by a series of small retouch scars along the interior of the notch.

Semi-steep

Removals are flat and invasive, and generally form a 30 degree - 75 degree angle with the blank surface.

Other

Blank

The flake, blade or bladelet from which a tool is manufactured.

APPENDIX C

CHIPPED STONE FROM DIBSI FARAJ EAST (OLSZEWSKI)

Table C-1. Tools from Dibsi Faraj East.

Tool	Number	%Type
Scrapers (12.5%)		
on flake	8	53.3
on retouched flake	2	13.3
on notched piece	1	6.7
on blade, bladelet	2	13.3
on retouched blade, bladelet	1	6.7
double	1	6.7
Total	15	
Perforators/Borers (5.8%)		
single perforator	3	42.9
small borer	3	42.9
on core	1	14.2
Total	7	
Burins (3.3%)		
dihedral	1	25.0
on break	1	25.0
on truncation	1	25.0
on natural edge	1	25.0
Total	4	
Backed Flakes, Blades (8.3%)		
backed flake	2	20.0
straight backed blade	1	10.0
convex backed blade	2	20.0
unretouched end	3	30.0
backed and truncated	1	10.0
fragment	1	10.0
Total	10	
Backed Bladelet (1.7%)		
pointed, straight backed	1	50.0
unretouched end	1	50.0
Total	2	

Table C-1. Tools from Dibsi Faraj East. cont'd

Tool	Number	%Type
Notches and Denticulates (11.7%)		
notched flakes	5	35.7
notched blades, bladelet	7	50.0
denticulated blade, bladelet	2	14.3
Total	14	
Truncations (7.5%)		
truncations	9	100.0
Total	9	
Geometrics (25.0%)		
lunates	29	96.7
isosceles triangle	1	3.3
Total	30	
Retouched Pieces (21.7%)		
flakes	15	57.7
blades	8	30.8
bladelets	3	11.5
Total	26	
Various (2.5%)		
sidescraper	1	33.3
backed knife	1	33.3
various	1	33.3
Total	3	
Tool Total	120	

Table C-2. Debitage from Dibsi Faraj East.

Debitage		Number
Flakes (57.1%)		
cortical		1
primary		56
flake		113
core trimming		3
retouch flakes		36
	Total	209
Blades (24.0%)		
cortical		28
single crest		19
multiple crest		33
rejuvenation		8
	Total	88
Bladelets (14.2%)		
cortical		7
single crest		28
multiple crest		16
rejuvenation		1
	Total	52
Burin Spalls (0.8%)		3
	Total	3
Microburins (2.2%)		
microburin		3
trihedral		2
krukowski		3
	Total	8
Debris (1.6%)		6
	Total	6
	Debitage Total	366

Table C-3. Cores from Dibsi Faraj East.

Cores	Number
Flake (62.5%)	
single platform	4
subpyramidal	1
2 platforms, perpendicular	1
polyhedral	3
subdiscoidal	1
Total	10
Blade (12.5%)	
single platform	1
rejected core	1
Total	2
Bladelet (18.8%)	
single platform	1
subpyramidal	2
Total	3
Indeterminate (6.2%)	
	1
Total	1
Core Total	16

Table C-4. Lunates from Dibsi Faraj East.

Lunates	Number
abrupt retouch	24
anvil retouch	5
Lunate Total	29

APPENDIX D

CHIPPED STONE ASSEMBLAGES FROM SELECTED LATE EPIPALEOLITHIC SITES

Table D-1. Tell Abu Huereya.

Type	Number	%
Scrapers	406	16.6
Borer/perforators	138	5.7
Burins	151	6.2
Sickle blades	0	0
Lunates	277	11.4
Other geometric microliths	43	1.7
Nongeometric microliths	235	9.7
Notch and/or denticulates	481	19.7
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	43	1.8
Various tools	622	27.2
Total tools	2435	

Data from examination.

Table D-2. Dibsi Faraj East

Type	Number	%
Scrapers	15	12.4
Borer/perforators	7	5.8
Burins	4	3.3
Sickle blades	0	0
Lunates	29	24.0
Other geometric microliths	1	0.8
Nongeometric microliths	2	1.6
Notch and/or denticulates	14	11.6
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	49	40.5
Total Tools	121	

Data from examination.

Table D-3. J2 (Wadi Judayid)

Type	Number	%
Scrapers	3	3.6
Borer/perforators	0	0
Burins	1	1.2
Sickle blades	0	0
Lunates	24	29.3
Other geometric microliths	0	0
Nongeometric microliths	6	7.3
Notch and/or denticulates	24	29.3
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	24	29.3
Total tools	82	

Data from Henry 1982:433

Table D-4 406a

Type	Number	%
Scrapers	1	2.0
Borer/perforators	3	6.1
Burins	0	0
Sickle blades	0	0
Lunates	24	49.0
Other geometric microliths	0	0
Nongeometric microliths	7	14.3
Notch and/or denticulates	9	18.4
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various Tools	5	0
Total tools	49	

Data from Henry 1982:433.

Table D-5 Rosh Horesha.

Type	Number	%
Scrapers	86	2.9
Borer/perforators	47	1.5
Burins	392	12.4
Sickle blades	19	0.6
Lunates	855	26.9
Other geometric microliths	107	3.4
Nongeometric microliths	191	6.0
Notch and/or denticulates	517	16.3
Massive scrapers	1	0.03
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	958	30.2
Total tools	3173	

Data from Marks and Larson 1977:208, 215-218.

Table D-6. Rosh Zin (midden/structure area).

Type	Number	%
Scrapers	89	7.3
Borer/perforators	24	2.0
Burins	128	10.5
Sickle blades	6	0.5
Lunates	349	28.7
Other geometric microliths	109	8.9
Nongeometric microliths	52	4.3
Notch and/or denticulates	182	14.9
Massive scrapers	4	0.3
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	274	22.5
Total tools	1217	

Data from Henry 1976:33-335.

Table D-7. Skukbah B.

Type	Number	%
Scrapers	38	4.5
Borer/perforators	34	4.0
Burins	35	4.2
Sickle blades	74	8.8
Lunates	283	33.7
Other geometric microliths	73	8.7
Nongeometric microliths	79	9.4
Notch and/or denticulates	5	0.6
Massive scrapers	44	5.2
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	176	20.9
Total tools	841	

Data from Garrod 1942:8-10.

Table D-8. Black Desert 14/7.

Type	Number	%
Scrapers	13	4.8
Borer/perforators	20	7.3
Burins	6	2.2
Sickle blades	1	0.4
Lunates	16	5.9
Other geometric microliths	3	1.1
Nongeometric microliths	23	8.5
Notch and/or denticulates	61	22.4
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	129	47.4
Total tools	272	

Data from Betts 1982:80.

Table D-9. Mugharet el-Wad B2.

Type	Number	%
Scrapers	129	1.7
Borer/perforators	238	3.1
Burins	174	2.3
Sickle blades	630	8.3
Lunates	4597	60.2
Other geometric microliths	453	5.9
Nongeometric microliths	1193	15.6
Notch and/or denticulates	34	0.4
Massive scrapers	12	0.2
Picks	29	0.4
Gouges, Axes, Blunted	0	0
Various tools	145	1.9
Total tools	7634	

Data from Garrod and Bate 1937:35-36.

Table D-10. Mugharet el-Wad B1.

Type	Number	%
Scrapers	39	0.9
Borer/perforators	117	2.8
Burins	123	3.0
Sickle blades	394	9.5
Lunates	2542	61.6
Other geometric microliths	258	6.3
Nongeometric microliths	453	11.0
Notch and/or denticulates	43	1.0
Massive scrapers	4	0.1
Picks	9	0.2
Gouges, Axes, Blunted	0	0
Various tools	146	3.5
Total tools	4128	

Data from Gerrod and Bate 1937:32-33.

Table D-11. Mugharet el-Kebarah B.

Type	Number	%
Scrapers	5	2.8
Borer/perforators	3	1.8
Burins	4	2.3
Sickle blades	67	39.4
Lunates	77	45.3
Other geometric microliths	3	1.8
Nongeometric microliths	5	2.9
Notch and/or denticulates	0	0
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	6	3.5
Total tools	170	

Data from examination (collections at Pitt-Rivers Museum, Cambridge Museum of Archaeology and Anthropology, British Museum).

Table D-12. Ain Mallaha III-IV.

Type	Number	%
Scrapers	20	2.8
Borer/perforators	26	3.5
Burins	106	14.2
Sickle blades	6	0.8
Lunates	42	5.6
Other geometric microliths	16	2.1
Nongeometric microliths	240	32
Notch and/or denticulates	81	10.8
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	211	28.2
Total tools	748	

Data from Valla 1975:4, Table I.

Table D-13. Ain Mallaha III.

Type	Number	%
Scrapers	28	4.1
Borer/perforators	25	3.6
Burins	92	13.3
Sickle blades	16	2.3
Lunates	37	5.4
Other geometric microliths	8	1.2
Nongeometric microliths	152	22.0
Notch and/or denticulates	112	16.2
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	220	31.9
Total tools	690	

Data from Valla 1975:4, Table I.

Table D-14. Ain Mallaha Ib.

Type	Number	%
Scrapers	13	2.0
Borer/perforators	17	2.7
Burins	68	10.7
Sickle blades	17	2.7
Lunates	43	6.7
Other geometric microliths	25	3.9
Nongeometric microliths	180	28.2
Notch and/or denticulates	89	14.0
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	186	29.1
Total tools	638	

Data from Valla 1975:4, Table I.

Table D-15. Nahal Oren VI.

Type	Number	%
Scrapers	11	2.1
Borer/perforators	12	2.3
Burins	46	8.9
Sickle blades	2	0.4
Lunates	93	17.9
Other geometric microliths	24	4.6
Nongeometric microliths	199	38.3
Notch and/or denticulates	56	10.8
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	76	14.6
Total tools	519	

Data from Valla 1981:72-73 (Jerusalem collection), and examination (British Museum collection).

Table D-16. Nahal Oren V.

Type	Number	%
Scrapers	11	1.5
Borer/perforators	16	2.2
Burins	61	8.3
Sickle blades	6	0.8
Lunates	133	18.2
Other geometric microliths	24	3.3
Nongeometric microliths	163	22.3
Notch and/or denticulates	124	17.0
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	193	26.4
Total tools	731	

Data from Valla 1981:72-73 (Jerusalem collection), and examination (British Museum collection).

Table D-17. El Khiam 7.

Type	Number	%
Scrapers	40	16.2
Borer/perforators	10	4.0
Burins	66	26.6
Sickle blades	0	0
Lunates	6	2.4
Other geometric microliths	26	10.5
Nongeometric microliths	43	17.3
Notch and/or denticulates	4	1.6
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	53	21.4
Total tools	248	

Data from Gonzalez-Echegaray 1966:96-97.

Table D-18. El Khiam 6.

Type	Number	%
Scrapers	51	15.0
Borer/perforators	10	2.9
Burins	98	28.7
Sickle blades	0	0
Lunates	15	4.4
Other geometric microliths	32	9.4
Nongeometric microliths	48	14.1
Notch and/or denticulates	8	2.3
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	79	23.2
Total tools	341	

Data from Gonzalez-Echegaray 1966:96-97.

Table D-19. El Khiam 5.

Type	Number	%
Scrapers	27	10.9
Borer/perforators	9	3.6
Burins	31	12.6
Sickle blades	0	0
Lunates	11	4.5
Other geometric microliths	29	11.8
Nongeometric microliths	58	23.6
Notch and/or denticulates	8	3.3
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	73	29.7
Total tools	246	

Data from Gonzalez-Echegaray 1966:96-97.

Table D-20. El Khiam 4.

Type	Number	%
Scrapers	49	15.3
Borer/perforators	25	7.8
Burins	41	12.8
Sickle blades	0	0
Lunates	22	6.9
Other geometric microliths	24	7.5
Nongeometric microliths	57	17.8
Notch and/or denticulates	12	3.8
Massive scrapers	0	0
Picks	0	0
Gouges, Axes, Blunted	0	0
Various tools	90	28.1
Total tools	320	

Data from Gonzalez-Echegaray 1966:96-97.

APPENDIX E

LUNATE RAW DATA

KEY: Column NO = number given to lunate

Column S = site number, as follows:

1 = Tell Abu Hureyra
2 = Rosh Horesha
3 = Rosh Zin
4 = Dibsi Faraj East
5 = Mugharet el-Wad
6 = Nahal Oren
7 = Mugharet el-Kebarah

Column L = level number, as follows:

blank = no designation
O = surface

number less than 900 = level number and numbers after the decimal point are as follows:

.1 = spit 1 at Tell Abu Hureyra
.2 = spit 2 at Tell Abu Hureyra
.4 = prime mark for Rosh Zin
.5 = A for Rosh Horesha

900-904 = Rosh Horesha, as follows:

900 = 1-4 cm.
901 = 10-15 cm.
902 = 20-25 cm.
903 = 30-35 cm.
904 = 35-40 cm.
910 = Mugharet el-Wad B2
911 = Mugharet el-Wad B2, British Museum Collection
920-924 = Nahal Oren, as follows:
920 = 7-1
921 = V
922 = VI
923 = VI-VII
930 = Mugharet el-Kebarah B

Column FN = field number or provenience, as follows:

1 = E22
2 = 74
3 = 72
4 = 16
5 = 3
6 = 12

7 = 5
8 = 11
9 = 15

400s and above are Tell Abu Hureyra field numbers

0000 = flotation residue from Tell Abu Hureyra

Column R = retouch type, as follows:

1 = normal abrupt
2 = inverse abrupt
3 = normal semi-steep
4 = inverse semi-steep
5 = normal invasive
6 = inverse invasive
7 = normal anvil
8 = inverse anvil
9 = normal fine
10 = inverse fine
11 = alternate normal and inverse abrupt
12 = Helwan

Column LEN = length to nearest 100th of a millimeter

Column MWID = midpoint width to nearest 100th of a millimeter

Column WWID = width at widest point to nearest 100th of a millimeter

Column LTWW = length to widest point width to nearest 100th of a millimeter

Column TH = thickness to nearest 100th of a millimeter

Column U = lunate tip which is positioned up (backed edge on left), as follows:

1 = intact
2 = burinated
3 = broken
4 = reworked
5 = perforator
6 = striking platform

Column D = lunate tip which is positioned down (backed edge on left), as follows:

1 = intact
2 = burinated
3 = broken
4 = reworked
5 = perforator
6 = striking platform

Column M = nonbacked edge modifications, as follows:

1 = no
2 = yes

Column T = modification type, as follows:

1 = nibbling
2 = notched
3 = denticulated
4 = retouched (backed)
5 = flat, invasive
6 = fine

Column P = polish visible to the naked eye, as follows:

1 = no
2 = yes
3 = trace

Table E-1. Lunate Raw Data. (1)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
203	1	311.0	585	11	34.80	8.70	8.70	17.40	2.75	0	0	0	0	0
204	1	311.0	585	1	31.65	7.45	7.95	19.70	3.30	0	0	0	0	0
205	1	311.0	565	1	26.85	6.60	6.80	18.20	4.30	0	0	0	0	0
206	1	311.0	585	1	28.60	7.10	7.20	18.70	3.90	0	0	0	0	0
207	1	311.0	585	1	22.70	6.70	7.10	12.45	3.10	1	1	1	0	2
208	1	311.0	585	7	25.50	6.90	7.60	11.40	3.10	0	0	0	0	0
209	1	326.0	620	1	29.20	6.85	7.00	16.10	2.65	0	0	0	0	0
210	1	326.0	620	1	30.50	7.50	7.50	15.25	2.60	0	0	0	0	0
211	1	317.0	597	1	31.25	8.35	8.60	18.65	2.50	0	0	0	0	0
212	1	323.0	603	7	33.60	8.40	8.40	16.60	4.85	0	0	0	0	0
213	1	323.0	603	7	31.00	8.00	8.30	13.45	3.70	0	0	0	0	0
214	1	323.0	603	7	27.25	6.25	6.40	11.30	3.45	0	0	0	0	0
215	1	324.0	602	7	33.80	7.75	7.75	16.90	4.80	1	1	2	1	2
216	1	324.0	602	1	26.00	7.90	8.45	11.25	2.90	0	0	0	0	0
217	1	318.0	598	1	32.70	11.40	11.70	15.70	4.50	0	0	0	0	0
218	1	319.0	599	1	28.45	7.60	8.50	12.00	2.60	0	0	0	0	0
219	1	311.0	586	1	36.90	7.35	8.00	27.40	3.30	0	0	0	0	0
220	1	313.0	589	7	17.70	4.75	5.00	10.00	2.45	0	0	0	0	0
221	1	312.0	588	1	26.00	8.05	8.70	18.40	4.95	0	0	0	0	0
222	1	312.0	588	7	27.10	7.50	7.50	13.55	3.45	0	0	0	0	0
223	1	312.0	588	1	22.95	7.90	7.90	11.40	2.85	0	0	0	0	0
224	1	314.0	590	1	30.30	7.50	7.75	13.60	2.60	0	0	0	0	0
225	1	314.0	590	1	36.00	10.75	10.75	18.00	3.20	0	0	0	0	0
226	1	315.0	593	7	26.80	7.40	7.40	13.40	4.25	0	0	0	0	0
227	1	315.0	593	7	32,40	7.20	8.05	14.20	5.10	0	0	0	0	0
228	1	315.0	593	1	24.40	7.50	7.50	12.20	2.90	0	0	0	0	0
229	1	315.0	593	11	26.40	8.50	8.85	9.70	3.70	0	0	0	0	0
230	1	316.0	595	11	24.00	4.30	4.90	6.45	2.65	0	0	0	0	0
231	1	316.0	595	1	21.70	8.45	8.45	10.65	4.30	0	0	0	0	0
232	1	316.0	595	1	25.20	5.90	6.10	14.50	2.70	0	0	0	0	0
233	1	316.0	595	1	25.90	6.00	7.25	17.60	3.00	0	0	0	0	0
234	1	316.0	595	1	48.00	10.30	12.10	19.60	4.40	0	0	0	0	0
235	1	316.0	595	11	27.25	6.80	6.80	13.60	3.60	0	0	0	0	0
236	1	323.2	612	1	27.50	7.60	7.35	17.95	3.10	0	0	0	0	0
250	1	324.2	608	1	31.60	8.20	8.20	15.80	3.00	0	0	0	0	0
598	1	313.0	0	1	19.50	5.20	5.60	9.65	2.65	1	1	2	1	1
599	1	323.0	0	1	19.70	6.30	6.45	10.95	2.80	2	2	2	3	2
600	1	323.0	0	1	20.65	5.95	5.95	10.30	1.60	3	1	1	0	1
601	1	324.2	0	1	20.85	5.65	5.75	10.50	2.50	1	3	2	2	1
602	1	324.1	0	1	26.05	6.50	7.00	16.55	4.95	5	1	2	2	1
603	1	326.0	0	1	28.40	6.40	6.40	14.20	3.45	3	1	1	0	1
604	1	326.0	0	1	21.35	6.25	6.25	10.60	4.00	3	1	1	0	1
605	1	294.0	542	1	31.10	7.15	7.15	15.50	2.40	3	1	1	0	1
606	1	294.0	542	1	23.60	5.45	5.50	10.70	1.85	3	1	2	1	1
607	1	305.0	574	1	33.90	10.65	10.85	18.60	3.50	3	3	2	2	2
608	1	305.0	574	1	25.90	7.45	7.80	15.35	2.50	2	1	2	1	1

Table E-1. Lunate Raw Data. (2)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
609	1	305.0	574	1	27.95	5.85	5.85	14.00	2.25	1	1	1	0	1
610	1	305.0	574	1	19.60	6.20	6.50	8.00	2.60	1	1	1	0	1
611	1	305.0	575	1	28.10	6.75	7.10	15.65	3.50	1	1	1	0	1
612	1	305.0	575	1	28.60	7.95	8.60	16.90	2.85	1	3	1	0	1
613	1	305.0	0	7	28.40	7.15	7.15	14.20	3.55	5	5	2	5	1
614	1	305.0	0	7	19.85	5.50	5.65	11.05	2.75	3	1	2	1	1
615	1	305.0	0	1	18.55	7.05	7.05	9.30	2.50	3	1	1	0	3
616	1	310.0	584	7	24.45	7.15	7.70	8.35	3.60	1	3	2	1	1
617	1	310.0	584	1	29.95	5.65	5.95	15.40	2.20	2	1	1	0	1
618	1	310.0	0	1	21.10	6.40	6.40	10.50	2.20	3	1	1	0	1
619	1	280.0	482	1	34.00	7.10	7.60	19.40	2.80	2	1	2	1	3
620	1	280.0	482	7	35.30	6.15	6.40	12.85	4.90	1	1	1	0	1
621	1	280.0	482	9	24.50	6.15	6.70	7.80	2.05	3	1	2	1	1
622	1	280.0	482	1	18.65	4.85	5.45	9.90	2.35	2	1	1	0	1
623	1	284.0	506	1	38.85	8.10	8.55	10.95	5.05	4	2	2	1	1
624	1	284.0	523	1	32.50	8.20	8.90	15.65	4.25	1	3	1	0	1
625	1	284.0	523	1	25.70	7.50	7.50	12.60	4.60	1	3	1	0	1
626	1	285.0	503	1	34.45	6.85	6.85	17.20	1.90	1	3	1	0	1
627	1	285.0	503	1	20.45	6.50	6.65	8.85	1.95	1	3	1	0	1
628	1	285.0	504	1	33.80	9.40	9.85	22.45	2.30	3	1	2	5	1
629	1	285.0	498	7	20.10	6.85	6.85	10.00	2.60	1	3	2	1	1
630	1	285.0	505	1	28.20	7.30	7.40	16.20	2.65	3	1	1	0	1
631	1	288.0	516	7	25.70	6.50	6.90	14.40	3.25	3	3	1	0	1
632	1	288.0	519	1	32.30	7.80	8.50	18.75	3.65	1	1	1	0	1
633	1	288.0	519	1	35.75	7.50	7.50	17.90	2.75	3	3	1	0	3
634	1	288.0	519	1	30.80	7.85	7.90	17.95	2.05	1	2	2	1	1
635	1	288.0	519	1	29.60	5.85	5.95	18.85	2.60	3	1	2	1	1
636	1	288.0	519	1	23.00	6.60	6.85	10.50	2.60	3	3	1	0	1
637	1	288.0	519	7	30.90	7.50	7.65	13.55	3.45	3	3	2	1	1
638	1	288.0	519	7	23.55	7.80	7.80	11.80	2.50	3	1	1	0	1
639	1	290.0	530	1	31.10	7.40	7.95	16.25	3.95	4	2	2	1	1
640	1	290.0	533	1	29.20	10.15	10.15	14.60	4.90	3	3	2	1	1
641	1	290.0	533	9	23.00	7.20	7.40	10.15	2.10	3	1	1	0	1
642	1	290.0	533	9	18.25	7.65	7.85	7.95	2.05	6	3	2	1	1
643	1	290.0	531	1	34.45	8.30	8.60	20.45	2.45	1	1	1	0	1
644	1	290.0	531	1	26.95	7.45	7.45	13.50	4.10	1	1	1	0	1
645	1	290.0	531	7	26.80	7.10	7.10	13.40	4.60	3	3	1	0	1
646	1	290.0	531	7	27.30	5.75	6.00	15.60	2.70	1	1	1	0	1
647	1	291.0	539	1	40.60	8.70	9.40	14.20	3.80	4	4	2	1	1
648	1	291.0	539	1	32.25	9.35	9.35	16.10	3.65	1	1	1	0	1
649	1	291.0	539	1	20.00	6.20	6.80	13.15	4.75	1	3	2	1	1
650	1	292.0	529	1	30.35	6.60	6.75	18.65	2.75	2	1	1	0	1
651	1	292.0	529	1	27.40	8.20	8.20	13.70	3.70	2	3	2	6	1
652	1	292.0	529	1	23.50	8.10	8.10	11.75	3.40	1	3	1	0	1
653	1	293.0	536	1	32.95	7.65	7.75	17.70	4.10	3	1	1	0	1
654	1	293.0	536	1	29.60	7.90	8.15	16.65	2.70	5	2	1	0	1

Table E-1. Lunate Raw Data. (3)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	J	D	M	T	P
655	1	293.0	537	1	27.15	7.35	7.35	13.60	2.60	1	1	1	0	1
656	1	293.0	537	1	25.55	9.90	10.25	13.90	3.35	3	3	2	1	1
657	1	293.0	547	7	30.35	6.70	6.70	15.20	3.90	1	3	1	0	1
658	1	293.0	547	1	29.90	8.25	6.60	14.40	3.40	1	3	1	0	1
659	1	293.0	547	1	24.10	10.20	10.45	12.10	2.95	1	3	2	1	1
660	1	296.0	543	1	23.70	6.60	6.60	11.85	2.10	1	3	2	4	1
661	1	296.0	543	1	20.80	6.85	7.10	11.70	2.60	1	3	2	1	1
662	1	296.0	543	1	20.90	6.60	7.40	11.75	3.65	3	1	1	0	1
663	1	297.0	550	1	29.10	8.85	8.85	14.55	4.10	1	1	2	1	1
664	1	297.0	550	1	28.30	8.20	8.20	14.15	2.05	4	3	2	1	1
665	1	297.0	550	1	21.10	5.15	5.15	10.55	2.00	3	1	1	0	1
666	1	297.0	552	7	25.45	5.60	6.20	13.95	2.90	1	2	1	0	1
667	1	297.0	554	1	31.60	3.35	8.65	17.95	2.90	2	2	1	0	1
668	1	297.0	554	1	28.20	7.85	8.60	16.70	2.25	1	1	1	0	3
669	1	297.0	554	1	28.75	9.75	9.75	14.35	3.60	1	4	1	0	1
670	1	297.0	554	7	31.90	7.20	7.55	16.80	3.70	1	1	1	0	1
671	1	297.0	554	7	29.80	8.95	8.95	14.90	3.15	3	3	1	0	1
672	1	298.0	556	1	26.30	7.25	7.25	13.15	3.25	3	1	2	1	1
673	1	298.0	558	1	28.10	6.55	8.90	14.95	3.40	3	3	2	2	1
674	1	298.0	558	7	27.70	8.50	9.00	18.05	5.60	1	1	1	0	1
675	1	298.0	559	1	30.10	8.25	8.55	16.80	2.55	1	1	1	0	1
676	1	298.0	559	1	26.90	8.05	8.55	14.35	2.60	1	1	2	5	1
677	1	299.0	556	7	18.90	4.90	5.05	7.40	3.20	1	2	1	0	1
678	1	299.0	556	1	28.55	6.30	6.50	15.15	1.80	1	3	2	3	1
679	1	300.0	561	1	28.30	8.80	8.95	11.75	3.90	1	3	2	1	1
680	1	300.0	561	1	24.70	6.90	7.10	11.80	2.45	1	1	2	4	1
681	1	300.0	561	1	22.35	7.95	7.95	11.20	3.20	1	4	1	0	1
682	1	301.0	564	1	32.70	5.20	5.60	11.05	2.70	3	3	2	1	1
683	1	301.0	564	1	25.80	6.40	6.70	16.50	1.75	1	1	1	0	1
684	1	302.0	567	1	33.60	6.90	7.20	14.60	3.50	1	1	1	0	1
685	1	303.0	570	1	46.05	9.60	10.25	16.10	3.05	1	1	1	0	1
686	1	303.0	570	1	22.40	7.05	7.05	11.20	2.85	2	4	2	6	1
687	1	304.0	572	1	26.30	6.45	6.60	14.55	3.40	1	1	1	0	1
688	1	304.0	572	1	24.60	8.95	8.95	12.30	4.00	3	3	2	1	1
689	1	307.0	578	1	23.90	6.35	6.80	14.15	1.85	1	1	1	0	1
690	1	308.0	580	1	31.90	6.95	7.45	20.15	2.40	3	3	2	1	1
691	1	308.0	580	1	29.00	9.00	9.00	14.50	4.95	3	3	1	0	3
692	1	308.0	580	1	25.30	10.30	10.95	5.90	3.60	1	1	1	0	1
693	1	308.0	580	1	25.00	9.85	9.95	12.50	3.75	4	4	2	1	1
694	1	308.0	580	7	29.20	7.75	7.80	15.05	4.25	3	3	2	1	1
695	1	281.1	491	1	29.60	7.95	8.20	21.30	4.00	4	3	1	0	1
696	1	281.1	491	1	27.30	7.15	7.15	13.65	2.60	1	2	1	0	1
697	1	281.1	491	11	18.45	6.00	6.60	9.60	2.55	3	1	1	0	1
698	1	281.2	493	1	35.90	7.10	7.10	17.95	3.00	1	1	2	1	1
699	1	281.2	493	7	36.60	7.75	8.00	14.85	3.10	1	1	1	0	1
700	1	281.2	493	7	35.00	7.20	7.60	22.40	4.10	3	3	1	0	1

Table E-1. Lunate Raw Data. (4)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
701	1	282.0	494	7	20.20	10.40	10.40	10.10	5.35	3	1	2	5	1
702	1	282.0	496	7	41.45	9.75	10.00	23.20	4.55	4	2	2	1	1
703	1	282.0	496	7	27.85	7.40	7.90	15.55	3.85	4	2	1	0	1
704	1	282.0	496	1	23.85	6.75	7.00	15.45	3.25	1	2	1	0	1
705	1	282.0	496	1	23.95	7.00	7.00	11.95	3.15	1	3	1	0	1
706	1	282.0	0	1	28.70	8.50	8.65	15.65	2.50	1	3	2	1	1
707	1	282.0	0	1	28.50	6.25	6.25	14.25	2.50	1	1	1	0	1
708	1	282.0	0	1	33.45	6.35	7.55	12.05	3.10	3	3	1	0	1
709	1	281.2	500	1	29.70	8.50	8.75	11.25	4.00	1	1	1	0	1
710	1	281.2	500	1	30.55	7.95	8.00	14.15	3.70	2	3	2	1	1
711	1	281.2	500	1	29.95	6.50	7.10	18.45	3.65	1	1	2	1	1
712	1	281.2	500	7	36.65	7.60	7.60	18.30	4.90	1	1	1	0	1
713	1	281.2	500	7	30.95	7.10	7.10	15.45	3.10	3	2	1	0	1
714	1	281.2	500	7	29.80	7.10	7.10	14.90	2.30	1	1	1	0	3
715	1	286.0	507	1	31.20	7.30	7.30	15.60	2.80	3	1	2	6	2
716	1	286.0	0	1	30.15	7.25	7.55	20.35	4.45	3	1	1	0	1
717	1	286.0	0	1	23.40	5.40	5.40	11.70	2.00	1	1	1	0	1
718	1	286.0	510	1	30.00	7.50	7.50	15.00	2.65	3	1	1	0	1
719	1	252.0	0	1	19.90	5.45	5.65	12.10	3.15	1	3	1	0	1
720	1	252.0	0	1	19.40	7.55	7.95	9.90	2.80	1	1	1	0	1
721	1	252.0	0	1	15.80	4.80	4.80	7.90	2.55	2	3	2	5	1
722	1	252.0	0	1	16.95	4.90	5.45	9.45	2.60	3	1	1	0	3
723	1	252.0	0	7	12.50	4.45	4.65	7.50	2.10	3	1	1	0	3
724	1	253.0	0	1	26.00	7.25	7.25	13.00	3.20	5	5	2	5	1
725	1	253.0	0	1	17.55	6.90	7.10	10.40	3.40	1	3	1	0	1
726	1	253.0	0	1	16.10	4.60	4.80	6.60	2.50	3	1	2	2	3
727	1	253.0	0	1	15.60	4.95	4.95	7.80	1.45	1	3	1	0	1
728	1	253.0	0	1	14.20	3.80	4.15	6.20	2.00	1	3	1	0	1
729	1	253.0	0	1	13.90	4.65	4.65	6.95	1.60	1	3	1	0	1
730	1	253.0	0	1	13.60	5.15	5.15	6.80	1.70	1	4	2	6	1
731	1	253.0	0	7	24.35	7.60	8.00	14.00	4.50	3	3	1	0	1
732	1	253.0	0	1	10.80	4.35	4.55	4.20	1.75	3	3	1	0	1
733	1	254.0	0	1	21.40	6.85	6.90	6.40	2.45	1	3	1	0	1
734	1	254.0	0	1	22.95	5.00	5.75	8.60	2.00	3	1	1	0	1
735	1	254.0	0	1	17.80	7.20	7.70	10.00	2.90	1	3	2	1	1
736	1	254.0	0	1	16.45	5.10	5.10	8.20	2.15	3	3	1	0	1
737	1	254.0	0	7	18.10	4.70	5.05	11.60	2.75	2	5	2	2	1
738	1	254.0	0	1	19.60	6.65	6.75	9.10	2.15	3	1	1	0	1
739	1	255.0	0	1	19.35	8.20	8.65	12.00	3.25	2	3	1	0	1
740	1	256.0	0	1	19.60	5.00	5.45	10.10	2.10	1	3	1	0	1
741	1	257.0	0	1	18.80	5.05	5.30	10.80	1.90	4	3	2	6	1
742	1	258.0	0	1	31.00	8.60	9.10	17.50	4.55	3	1	1	0	1
743	1	261.0	0	1	25.45	7.40	7.50	12.00	3.45	1	1	1	0	1
744	1	265.0	0	1	17.00	6.95	7.55	10.00	2.80	5	3	2	3	1
745	1	265.0	0	1	23.45	6.85	6.85	11.70	1.65	1	1	1	0	1
746	1	265.0	0	1	21.60	5.50	5.50	10.80	3.35	1	1	1	0	1

Table E-1. Lunate Raw Data. (5)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
747	1	265.0	434	1	32.90	7.95	8.00	16.60	4.10	2	1	1	0	1
748	1	265.0	434	1	29.85	7.85	6.20	19.50	3.05	1	1	1	0	1
749	1	265.0	434	1	29.00	8.20	6.20	14.50	3.90	3	3	2	1	1
750	1	268.0	0	1	21.90	5.45	5.45	10.90	2.50	1	2	1	0	1
751	1	268.0	0	7	20.80	7.70	8.10	8.70	3.40	3	2	1	0	1
752	1	268.0	0	1	20.60	5.10	5.35	9.00	2.30	1	1	1	0	1
753	1	268.0	447	1	37.10	7.30	7.30	19.55	3.50	1	1	1	0	1
754	1	268.0	447	1	33.00	7.00	7.40	13.45	3.80	1	3	1	0	1
755	1	268.0	447	1	35.00	8.70	8.95	14.40	3.30	1	1	2	1	1
756	1	268.0	447	1	31.30	9.25	10.30	21.15	2.65	3	1	1	0	1
757	1	268.0	447	1	28.85	8.05	9.55	18.00	5.95	3	1	2	5	1
758	1	268.0	447	1	22.15	5.80	5.80	11.05	3.50	3	3	1	0	1
759	1	268.0	447	7	32.95	6.70	7.30	12.95	3.00	3	1	1	0	1
760	1	271.2	465	1	34.30	6.20	6.20	17.15	2.15	2	1	2	1	1
761	1	271.2	465	1	30.60	9.30	9.80	17.65	4.30	1	1	2	5	1
762	1	271.2	465	11	22.55	6.20	6.75	12.65	2.30	1	1	2	2	1
763	1	271.0	0	1	22.70	5.40	5.95	12.10	3.85	2	3	1	0	1
764	1	274.0	471	1	33.90	6.75	7.30	21.70	2.25	1	3	2	1	1
765	1	274.0	471	1	30.70	8.10	8.10	15.35	2.95	3	1	1	0	1
766	1	274.0	471	1	23.55	7.50	7.50	12.80	3.60	3	3	2	1	1
767	1	274.0	467	1	34.90	6.45	6.55	19.55	2.20	1	1	1	0	1
768	1	274.0	0	7	23.05	7.00	7.30	9.75	2.70	1	1	1	0	1
769	1	274.0	0	1	18.05	5.80	5.80	9.00	2.95	2	3	1	0	1
770	1	275.0	0	7	17.50	5.05	5.05	6.75	3.10	1	1	1	0	1
771	1	275.0	0	1	14.20	5.60	5.60	7.10	2.95	1	3	1	0	1
772	1	277.0	476	1	24.45	7.60	7.60	12.20	3.05	1	3	1	0	1
773	1	277.0	476	1	23.25	4.90	4.90	11.60	1.85	2	1	1	0	1
774	1	279.0	486	1	36.20	7.35	8.70	15.65	2.60	3	3	2	1	1
775	1	279.0	486	1	35.95	8.25	9.15	21.30	3.00	2	1	2	1	1
776	1	279.0	486	1	27.15	7.20	7.20	13.55	2.30	1	1	1	0	1
777	1	279.0	486	1	25.50	6.35	6.65	10.55	2.25	1	1	1	0	1
778	1	279.0	486	1	21.60	6.50	7.00	12.95	3.50	3	1	1	0	1
779	1	54.0	113	1	22.30	6.85	7.30	10.40	2.65	4	4	2	5	1
780	1	54.0	113	1	27.20	8.80	10.15	10.25	4.55	1	3	2	1	1
781	1	54.0	113	1	36.20	6.50	6.50	18.10	3.95	3	3	1	0	1
14	2	4.0	2	7	18.85	4.85	5.40	8.10	1.35	0	0	0	0	0
15	2	4.0	2	7	11.75	3.40	3.50	9.50	2.00	0	0	0	0	0
16	2	4.0	2	1	13.25	3.90	4.00	5.20	1.90	0	0	0	0	0
17	2	4.0	2	1	18.40	3.60	3.60	9.20	1.75	0	0	0	0	0
18	2	4.0	2	1	30.05	8.50	8.50	15.00	4.80	0	0	0	0	0
19	2	2.5	3	1	29.50	8.30	8.30	14.75	2.90	0	0	0	0	0
20	2	2.5	3	1	23.50	5.55	5.90	11.90	2.70	0	0	0	0	0
21	2	2.5	3	7	17.30	3.40	3.50	9.80	2.30	0	0	0	0	0
22	2	2.5	3	7	12.30	3.00	3.00	6.15	1.95	0	0	0	0	0
23	2	2.5	3	7	13.60	3.70	3.75	5.20	1.90	0	0	0	0	0
24	2	6.0	2	1	26.90	5.75	5.75	13.45	2.00	0	0	0	0	0

Table E-1. Lunate Raw Data. (6)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
25	2	6.0	2	1	26.30	8.80	9.30	11.00	3.95	0	0	0	0	0
26	2	6.0	2	7	30.10	6.70	6.70	15.05	3.65	0	0	0	0	0
27	2	6.0	2	7	25.00	8.10	9.50	13.10	2.45	0	0	0	0	0
28	2	6.0	2	1	29.30	9.70	9.70	14.65	2.70	0	0	0	0	0
29	2	6.0	2	1	22.00	5.90	6.15	10.90	2.85	0	0	0	0	0
30	2	6.0	2	7	25.95	7.50	8.20	20.20	3.50	0	0	0	0	0
31	2	6.0	2	1	20.90	6.45	6.90	13.10	2.70	0	0	0	0	0
32	2	6.0	2	7	17.80	6.70	6.80	7.10	2.75	0	0	0	0	0
33	2	6.0	2	7	20.50	7.20	7.20	10.25	3.10	0	0	0	0	0
34	2	6.0	2	1	25.50	6.65	7.25	9.60	3.00	0	0	0	0	0
35	2	6.0	2	1	20.15	6.95	7.40	10.20	2.65	0	0	0	0	0
36	2	6.0	2	7	15.55	3.20	3.20	7.75	2.10	0	0	0	0	0
37	2	6.0	2	1	13.50	3.60	3.60	6.75	1.45	0	0	0	0	0
38	2	6.0	2	7	15.30	3.70	3.90	9.70	1.60	0	0	0	0	0
39	2	6.0	2	7	14.10	3.60	3.60	7.05	1.80	0	0	0	0	0
40	2	6.0	2	7	12.60	3.60	3.80	8.00	1.70	0	0	0	0	0
41	2	7.0	2	7	16.00	2.85	2.85	6.00	1.90	0	0	0	0	0
42	2	7.0	2	7	18.00	4.15	4.40	11.45	2.20	0	0	0	0	0
43	2	7.0	2	1	15.65	4.30	4.30	7.80	1.90	0	0	0	0	0
44	2	7.0	2	1	27.10	6.60	6.65	11.00	2.50	0	0	0	0	0
45	2	7.0	2	1	24.10	7.50	7.80	9.30	1.80	0	0	0	0	0
46	2	7.0	2	11	27.10	9.35	9.35	13.55	4.20	0	0	0	0	0
47	2	7.0	2	1	29.50	8.25	8.50	13.05	3.15	0	0	0	0	0
48	2	7.0	2	11	38.20	7.45	8.75	17.90	4.55	0	0	0	0	0
49	2	6.0	2	1	30.15	9.10	9.10	15.05	3.90	0	0	0	0	0
50	2	6.0	2	1	28.30	8.10	8.50	10.80	2.20	0	0	0	0	0
51	2	6.0	2	1	26.00	8.40	8.90	16.00	3.20	0	0	0	0	0
52	2	6.0	2	1	29.30	8.70	9.00	14.80	2.20	0	0	0	0	0
53	2	6.0	2	1	24.80	7.50	7.50	12.45	2.30	0	0	0	0	0
54	2	6.0	2	1	19.80	8.30	8.80	7.00	2.80	0	0	0	0	0
55	2	6.0	2	1	21.30	8.10	8.65	10.10	3.00	0	0	0	0	0
56	2	6.0	2	1	19.55	7.20	7.20	9.70	3.10	0	0	0	0	0
57	2	6.0	2	1	18.60	3.75	3.75	9.30	1.80	0	0	0	0	0
58	2	6.0	2	1	13.10	3.70	3.70	6.50	1.50	0	0	0	0	0
59	2	5.0	3	7	14.60	3.45	3.45	7.30	2.45	0	0	0	0	0
60	2	5.0	3	7	14.60	3.10	3.10	7.30	1.80	0	0	0	0	0
61	2	5.0	3	11	16.20	3.70	3.90	8.25	2.40	0	0	0	0	0
62	2	5.0	3	1	29.40	5.75	5.90	18.30	1.65	0	0	0	0	0
63	2	5.0	3	1	24.55	7.70	7.70	12.20	2.90	0	0	0	0	0
64	2	5.0	3	1	27.60	7.50	7.70	15.20	2.65	0	0	0	0	0
65	2	5.0	3	1	14.00	4.30	4.30	7.00	1.20	0	0	0	0	0
66	2	5.0	3	7	15.10	3.45	3.60	5.30	1.70	0	0	0	0	0
67	2	5.0	3	11	12.40	4.30	4.30	6.20	2.40	0	0	0	0	0
68	2	5.0	3	1	25.05	8.10	9.50	14.40	3.80	0	0	0	0	0
69	2	5.0	3	7	16.40	4.30	4.30	6.20	2.35	0	0	0	0	0
70	2	5.0	3	1	13.50	3.95	3.95	6.75	2.05	0	0	0	0	0

Table E-1. Lunate Raw Data. (7)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
71	2	5.0	3	7	12.30	3.50	3.65	8.00	1.40	0	0	0	0	0
72	2	5.0	3	1	15.00	4.10	4.10	7.50	2.20	0	0	0	0	0
73	2	5.0	3	1	21.10	4.90	4.90	10.55	2.10	0	0	0	0	0
74	2	5.0	3	1	28.85	7.00	7.65	13.80	1.90	0	0	0	0	0
75	2	5.0	3	7	25.50	8.50	6.50	12.75	4.40	0	0	0	0	0
76	2	5.0	3	7	18.20	3.85	4.00	10.00	1.55	0	0	0	0	0
77	2	5.0	3	7	11.10	3.40	3.40	5.55	1.90	0	0	0	0	0
78	2	903.0	4	1	21.55	6.25	6.50	10.70	3.70	0	0	0	0	0
79	2	903.0	4	7	20.60	5.40	5.50	7.20	2.80	0	0	0	0	0
80	2	901.0	4	1	23.50	8.80	9.10	10.10	3.40	0	0	0	0	0
81	2	901.0	4	1	20.85	6.45	6.60	10.20	1.75	0	0	0	0	0
82	2	901.0	4	7	22.65	8.45	8.45	11.30	2.20	0	0	0	0	0
83	2	901.0	4	11	11.35	3.80	3.80	5.65	1.90	0	0	0	0	0
84	2	3.0	3	7	11.95	4.20	4.25	7.90	2.50	0	0	0	0	0
85	2	3.0	3	7	15.40	3.25	3.50	9.70	2.00	0	0	0	0	0
86	2	3.0	3	7	31.60	8.80	9.40	21.45	4.80	0	0	0	0	0
87	2	3.0	3	1	27.20	8.40	8.40	13.60	3.20	0	0	0	0	0
88	2	3.0	3	1	22.25	6.90	6.90	11.10	3.25	0	0	0	0	0
89	2	3.0	3	7	15.50	3.60	3.60	7.75	1.65	0	0	0	0	0
90	2	902.0	4	1	21.60	6.30	6.60	9.90	2.80	0	0	0	0	0
91	2	904.0	4	1	27.50	9.05	9.10	16.20	3.10	0	0	0	0	0
92	2	904.0	4	1	30.20	10.25	10.55	13.90	4.45	0	0	0	0	0
93	2	904.0	4	1	34.90	8.90	9.60	13.90	6.30	0	0	0	0	0
94	2	904.0	4	1	29.40	8.15	8.15	14.70	3.15	0	0	0	0	0
95	2	904.0	4	1	26.70	8.10	8.10	13.35	2.20	0	0	0	0	0
96	2	904.0	4	1	28.20	8.90	8.90	14.20	3.45	0	0	0	0	0
97	2	904.0	4	1	25.00	8.00	8.15	16.00	3.60	0	0	0	0	0
98	2	904.0	4	1	25.30	9.50	9.85	15.30	4.10	0	0	0	0	0
99	2	904.0	4	1	28.40	8.65	8.70	9.55	3.40	0	0	0	0	0
100	2	904.0	4	1	23.80	5.55	5.55	11.90	1.90	0	0	0	0	0
101	2	904.0	4	1	22.20	6.05	6.05	11.10	3.70	0	0	0	0	0
102	2	904.0	4	1	25.10	9.05	9.70	8.80	3.20	0	0	0	0	0
103	2	904.0	4	1	22.70	7.60	7.60	11.35	2.25	0	0	0	0	0
104	2	904.0	4	1	20.00	6.15	6.60	9.45	2.40	0	0	0	0	0
105	2	904.0	4	11	19.00	5.35	5.35	9.50	2.50	0	0	0	0	0
106	2	904.0	4	7	22.10	6.40	6.40	11.05	2.90	0	0	0	0	0
107	2	904.0	4	1	17.90	7.50	7.80	11.90	2.90	0	0	0	0	0
108	2	904.0	4	7	24.90	7.40	8.00	13.00	3.10	0	0	0	0	0
109	2	904.0	4	7	17.65	5.20	5.20	8.60	3.10	0	0	0	0	0
110	2	904.0	4	11	17.40	5.40	5.55	5.00	2.60	0	0	0	0	0
111	2	8.0	5	1	23.80	7.25	7.95	7.50	2.55	0	0	0	0	0
112	2	8.0	5	1	27.90	7.85	7.85	13.95	1.80	0	0	0	0	0
113	2	8.0	5	1	21.90	5.80	5.80	10.95	2.60	0	0	0	0	0
114	2	8.0	5	1	21.80	6.50	6.70	9.50	2.00	0	0	0	0	0
1	3	1.4	1	1	17.00	6.55	6.55	8.55	3.70	0	0	0	0	0
2	3	1.4	1	1	17.60	6.10	6.15	7.20	2.25	0	0	0	0	0

Table E-1. Lunate Raw Data. (8)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	O	M	T	P
3	3	1.4	1	7	19.65	5.10	5.20	10.00	3.00	0	0	0	0	0
4	3	1.4	1	7	21.20	5.55	5.75	11.95	2.95	0	0	0	0	0
5	3	1.4	1	1	16.40	7.30	7.75	7.70	2.25	0	0	0	0	0
6	3	2.4	1	1	21.90	9.10	9.35	7.60	3.20	0	0	0	0	0
7	3	2.4	1	1	16.10	4.70	5.00	8.10	1.90	0	0	0	0	0
8	3	2.4	1	1	17.35	5.25	5.30	8.50	3.20	0	0	0	0	0
9	3	2.4	1	7	21.30	6.80	6.80	10.65	3.80	0	0	0	0	0
10	3	2.4	1	1	13.40	4.45	4.50	5.15	1.50	0	0	0	0	0
11	3	2.4	1	1	21.00	6.45	6.90	9.25	1.85	0	0	0	0	0
12	3	1.0	1	12	30.90	9.10	9.20	11.50	3.60	0	0	0	0	0
13	3	2.0	1	1	16.05	6.00	6.15	5.95	2.10	0	0	0	0	0
115	3	2.5	1	1	22.15	7.50	7.65	12.65	2.65	0	0	0	0	0
116	3	2.5	1	1	21.25	6.75	6.80	12.10	2.90	0	0	0	0	0
117	3	2.5	1	1	26.10	7.50	7.50	13.05	2.40	0	0	0	0	0
118	3	2.5	1	1	23.60	6.70	7.15	13.90	3.10	0	0	0	0	0
119	3	2.5	1	1	21.50	7.10	7.10	10.75	3.25	0	0	0	0	0
120	3	2.5	1	1	30.90	9.90	10.45	16.25	2.70	0	0	0	0	0
121	3	2.5	1	1	21.25	7.30	7.65	10.90	2.55	0	0	0	0	0
122	3	2.5	1	1	24.20	8.00	8.60	13.60	3.00	0	0	0	0	0
123	3	2.5	1	1	21.80	6.20	6.35	9.10	2.50	0	0	0	0	0
124	3	2.5	1	1	20.55	7.25	7.25	10.20	2.65	0	0	0	0	0
125	3	2.5	1	1	18.50	5.25	5.50	6.30	2.50	0	0	0	0	0
126	3	2.5	1	1	16.50	5.60	5.60	8.30	2.80	0	0	0	0	0
127	3	2.5	1	1	20.50	6.60	6.95	6.95	2.35	0	0	0	0	0
128	3	2.5	1	1	16.60	6.05	6.15	6.20	2.65	0	0	0	0	0
129	3	2.5	1	1	21.50	7.80	7.95	9.00	3.45	0	0	0	0	0
130	3	2.5	1	1	18.95	6.80	6.80	9.40	1.80	0	0	0	0	0
131	3	2.5	1	1	18.20	6.65	7.60	7.40	1.90	0	0	0	0	0
132	3	2.5	1	1	19.50	5.95	6.95	8.65	3.30	0	0	0	0	0
133	3	2.5	1	1	18.70	7.10	7.10	9.35	2.10	0	0	0	0	0
134	3	2.5	1	1	19.00	6.10	6.10	9.50	2.40	0	0	0	0	0
135	3	2.5	1	1	17.40	6.50	6.95	7.40	2.45	0	0	0	0	0
136	3	2.5	1	1	20.20	4.95	5.00	10.55	1.60	0	0	0	0	0
137	3	2.5	1	1	15.10	5.80	6.20	6.80	1.55	0	0	0	0	0
136	3	2.5	1	1	16.60	5.40	5.50	8.00	2.55	0	0	0	0	0
139	3	2.5	1	7	20.10	6.05	6.05	10.05	3.15	0	0	0	0	0
140	3	2.5	1	7	19.90	6.05	6.20	10.40	3.95	0	0	0	0	0
141	3	2.5	1	7	17.25	5.40	5.40	8.60	3.20	0	0	0	0	0
142	3	10.0	6	1	19.90	5.75	5.90	11.40	2.65	0	0	0	0	0
143	3	10.0	6	1	18.55	4.40	4.40	9.20	1.65	0	0	0	0	0
144	3	10.0	6	11	22.40	7.30	8.00	12.65	4.20	0	0	0	0	0
145	3	1.5	1	12	20.70	6.60	6.75	12.60	2.70	0	0	0	0	0
146	3	1.5	1	1	20.50	5.90	5.90	10.20	3.65	0	0	0	0	0
147	3	1.5	1	1	22.20	6.95	7.10	9.20	2.15	0	0	0	0	0
148	3	1.5	1	1	22.20	6.70	6.80	10.95	2.45	0	0	0	0	0
149	3	1.5	1	1	20.70	7.65	7.70	12.65	2.10	0	0	0	0	0

Table E-1. Lunate Raw Data. (9)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
150	3	1.5	1	1	18.65	6.20	6.60	10.00	2.65	0	0	0	0	0
151	3	1.5	1	1	21.05	6.60	6.60	9.30	2.25	0	0	0	0	0
152	3	1.5	1	1	17.80	6.20	6.30	8.25	2.50	0	0	0	0	0
153	3	1.5	1	1	17.80	6.90	7.10	11.30	2.90	0	0	0	0	0
154	3	1.5	1	11	17.80	5.90	6.00	7.40	2.10	0	0	0	0	0
155	3	1.5	1	1	17.05	6.50	6.50	8.50	1.65	0	0	0	0	0
156	3	1.5	1	2	13.75	3.25	3.50	7.80	2.00	0	0	0	0	0
157	3	1.5	1	1	16.80	4.20	4.20	6.40	1.60	0	0	0	0	0
158	3	1.5	1	7	19.60	6.05	6.05	9.60	4.45	0	0	0	0	0
159	3	1.5	1	1	15.30	6.05	6.95	7.30	2.55	0	0	0	0	0
160	3	1.5	1	1	11.50	2.55	3.00	6.90	1.50	0	0	0	0	0
161	3	900.0	1	1	18.15	6.20	6.20	9.00	1.70	0	0	0	0	0
162	3	900.0	1	1	20.80	6.25	6.25	10.40	2.50	0	0	0	0	0
163	3	900.0	1	7	13.95	3.60	3.60	6.90	2.20	0	0	0	0	0
164	3	900.0	1	7	13.35	4.15	4.15	6.70	1.80	0	0	0	0	0
165	3	3.0	1	1	22.65	7.90	8.25	15.20	3.35	0	0	0	0	0
166	3	4.0	1	1	23.25	5.60	5.60	11.60	2.25	0	0	0	0	0
167	3	3.0	5	7	17.00	5.20	5.20	8.50	2.60	0	0	0.	0	0
168	3	3.0	4	1	22.15	5.50	5.50	11.10	1.90	0	0	0	0	0
169	3	1.0	8	7	24.30	6.35	6.35	12.15	3.65	0	0	0	0	0
170	3	3.0	4	1	24.85	7.00	7.20	9.30	3.30	0	0	0	0	0
171	3	1.0	4	1	21.60	7.50	7.50	10.60	3.25	0	0	0	0	0
172	3	5.0	4	1	20.75	5.20	5.20	10.35	2.00	0	0	0	0	0
173	3	2.0	4	1	16.50	4.65	4.65	8.25	1.25	0	0	0	0	0
174	3	4.0	4	1	23.30	7.75	7.75	11.65	3.15	0	0	0	0	0
175	3	4.0	4	1	21.80	8.00	8.10	9.60	2.90	0	0	0	0	0
176	3	1.0	4	1	12.70	3.75	3.75	6.35	1.60	0	0	0	0	0
177	3	2.0	4	7	16.25	3.80	3.80	8.10	1.95	0	0	0	0	0
178	3	3.0	8	1	24.85	7.65	7.70	13.95	2.10	0	0	0	0	0
179	3	1.0	8	7	18.30	3.80	3.60	9.15	2.20	0	0	0	0	0
180	3	2.0	9	1	19.00	5.55	5.55	9.50	1.70	0	0	0	0	0
181	3	1.0	4	1	24.10	6.30	6.45	10.45	2.65	0	0	0	0	0
182	3	3.0	8	7	15.60	3.45	3.75	8.10	1.50	0	0	0	0	0
183	3	5.0	4	7	22.70	5.50	5.90	11.20	2.70	0	0	0	0	0
184	3	4.0	7	1	16.30	4.15	4.20	10.10	1.60	0	0	0	0	0
185	3	3.0	4	1	18.70	5.95	5.95	9.35	2.05	0	0	0	0	0
186	3	4.0	4	1	17.50	6.00	6.00	8.75	1.90	0	0	0	0	0
187	3	3.0	8	7	23.10	6.85	6.85	11.55	3.35	0	0	0	0	0
188	3	3.0	7	1	18.55	6.00	6.10	10.55	2.25	0	0	0	0	0
189	3	2.0	4	1	19.50	6.00	6.20	8.65	3.00	0	0	0	0	0
190	3	3.0	4	1	20.90	6.10	6.25	10.35	2.20	0	0	0	0	0
191	3	2.0	8	1	21.20	6.25	6.50	10.20	2.10	0	0	0	0	0
192	3	3.0	4	1	18.45	7.90	8.00	8.40	2.60	0	0	0	0	0
193	3	2.0	7	1	19.80	7.35	7.35	9.90	3.20	0	0	0	0	0
194	3	3.0	4	1	19.60	7.00	7.10	7.65	1.90	0	0	0	0	0
195	3	1.0	7	1	18.85	6.05	6.15	11.05	2.50	0	0	0	0	0

Table E-1. Lunate Raw Data. (10)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TM	U	D	M	T	P
196	3	3.0	4	1	17.65	5.95	6.00	10.00	2.00	0	0	0	0	0
197	3	1.0	9	7	20.50	6.60	6.60	10.25	3.60	0	0	0	0	0
198	3	1.0	8	1	17.30	5.65	5.65	8.65	1.30	0	0	0	0	0
199	3	2.0	9	1	18.50	5.20	5.40	8.50	1.95	0	0	0	0	0
200	3	4.0	9	7	21.30	6.30	6.55	12.50	3.00	0	0	0	0	0
201	3	3.0	8	1	14.20	3.90	3.90	7.10	1.40	0	0	0	0	0
202	3	1.0	7	7	14.15	3.65	3.65	7.05	2.10	0	0	0	0	0
237	4	0.0	0	1	24.35	8.40	8.40	12.20	3.30	0	0	0	0	0
238	4	0.0	0	1	29.50	7.45	8.20	8.90	2.60	0	0	0	0	0
239	4	0.0	0	1	36.70	8.90	8.90	18.35	4.75	0	0	0	0	0
240	4	0.0	0	11	35.20	8.10	9.00	24.50	3.35	0	0	0	0	0
241	4	0.0	0	1	29.55	7.40	7.50	18.50	2.30	0	0	0	0	0
242	4	0.0	0	1	23.55	6.35	6.35	11.75	3.35	0	0	0	0	0
243	4	0.0	0	1	29.20	6.10	6.60	10.50	3.40	0	0	0	0	0
244	4	0.0	0	1	32.45	8.00	6.35	16.30	3.00	0	0	0	0	0
245	4	0.0	0	1	40.25	10.50	10.60	21.70	4.70	0	0	0	0	0
246	4	0.0	0	1	30.50	7.55	7.55	15.25	2.70	0	0	0	0	0
247	4	0.0	0	7	31.80	8.30	8.30	15.90	3.20	0	0	0	0	0
248	4	0.0	0	11	23.90	7.60	8.00	15.50	4.70	0	0	0	0	0
249	4	0.0	0	11	27.90	6.45	6.45	13.95	3.45	0	0	0	0	0
251	5	910.0	0	1	15.60	4.60	4.70	6.95	1.35	0	0	0	0	0
252	5	910.0	0	1	20.25	4.95	5.30	6.95	1.80	0	0	0	0	0
253	5	910.0	0	12	21.50	6.00	6.00	10.75	2.60	0	0	0	0	0
254	5	910.0	0	12	17.90	6.10	6.70	6.50	4.30	0	0	0	0	0
255	5	910.0	0	1	19.20	4.40	4.60	12.55	2.10	0	0	0	0	0
256	5	910.0	0	11	15.90	3.35	3.45	7.75	2.15	0	0	0	0	0
257	5	910.0	0	12	15.25	5.40	5.40	7.60	2.40	0	0	0	0	0
258	5	910.0	0	12	15.20	5.90	5.95	5.45	2.15	0	0	0	0	0
259	5	910.0	0	12	14.60	5.10	5.10	7.30	2.05	0	0	0	0	0
260	5	910.0	0	1	19.15	9.35	9.35	9.55	2.60	0	0	0	0	0
261	5	910.0	0	12	20.80	6.00	6.25	11.75	2.20	0	0	0	0	0
262	5	910.0	0	12	21.45	5.30	5.40	9.50	2.15	0	0	0	0	0
263	5	910.0	0	12	23.30	8.60	8.60	11.60	3.00	0	0	0	0	0
264	5	910.0	0	1	13.95	3.80	4.00	6.50	1.80	0	0	0	0	0
265	5	910.0	0	11	16.20	4.65	5.20	7.20	2.10	0	0	0	0	0
266	5	910.0	0	12	17.75	7.10	7.10	6.85	2.00	0	0	0	0	0
267	5	910.0	0	7	16.45	5.80	5.55	6.00	3.40	0	0	0	0	0
268	5	910.0	0	12	21.90	6.95	7.45	17.15	3.25	0	0	0	0	0
269	5	910.0	0	12	17.90	4.65	4.65	8.95	1.60	0	0	0	0	0
270	5	910.0	0	12	22.55	8.10	8.10	11.20	3.20	0	0	0	0	0
271	5	910.0	0	1	13.80	4.70	4.70	6.90	2.60	0	0	0	0	0
272	5	910.0	0	1	15.90	4.75	4.80	6.10	1.95	0	0	0	0	0
273	5	910.0	0	1	14.30	4.40	4.50	6.00	1.95	0	0	0	0	0
274	5	910.0	0	1	13.00	5.40	5.85	5.30	1.75	0	0	0	0	0
275	5	910.0	0	1	18.40	4.40	4.40	9.20	1.95	0	0	0	0	0
276	5	910.0	0	1	18.60	4.25	4.40	7.30	2.15	0	0	0	0	0

Table E-1. Lunate Raw Data. (11)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
277	5	910.0	0	1	18.60	7.00	7.00	9.30	2.60	0	0	0	0	0
278	5	910.0	0	1	20.60	7.40	7.85	8.95	1.40	0	0	0	0	0
279	5	910.0	0	1	17.30	5.25	5.40	9.50	2.00	0	0	0	0	0
280	5	910.0	0	1	13.15	4.40	4.50	5.45	2.15	0	0	0	0	0
281	5	910.0	0	1	17.00	4.40	4.40	8.50	2.70	0	0	0	0	0
282	5	910.0	0	1	15.80	5.10	5.10	7.90	2.45	0	0	0	0	0
283	5	910.0	0	1	13.10	4.50	4.50	6.55	2.65	0	0	0	0	0
284	5	910.0	0	1	17.05	4.60	4.90	9.15	1.70	0	0	0	0	0
285	5	910.0	0	1	15.60	4.60	4.60	7.80	2.15	0	0	0	0	0
286	5	910.0	0	1	15.20	4.85	5.45	7.00	2.90	0	0	0	0	0
287	5	910.0	0	1	17.00	4.00	4.00	8.50	2.10	0	0	0	0	0
288	5	910.0	0	1	19.10	4.30	4.40	7.45	2.10	0	0	0	0	0
289	5	910.0	0	1	19.20	5.20	5.75	10.40	1.85	0	0	0	0	0
290	5	910.0	0	1	19.50	4.60	5.10	10.10	2.35	0	0	0	0	0
291	5	910.0	0	1	14.75	3.80	3.80	7.35	2.00	0	0	0	0	0
292	5	910.0	0	1	24.90	7.90	6.40	10.00	1.70	0	0	0	0	0
293	5	910.0	0	1	15.70	4.90	5.30	6.35	1.80	0	0	0	0	0
294	5	910.0	0	1	16.90	4.00	4.00	6.45	2.25	0	0	0	0	0
295	5	910.0	0	1	16.20	4.60	5.10	7.90	3.10	0	0	0	0	0
296	5	910.0	0	1	13.85	4.80	4.80	6.90	2.40	0	0	0	0	0
297	5	910.0	0	1	16.80	4.45	4.70	13.75	2.35	0	0	0	0	0
298	5	910.0	0	1	15.20	4.55	4.80	6.40	1.60	0	0	0	0	0
299	5	910.0	0	4	17.70	6.00	6.50	7.40	1.85	0	0	0	0	0
300	5	910.0	0	11	18.70	5.90	6.10	9.80	2.65	0	0	0	0	0
301	5	910.0	0	11	15.20	5.60	5.95	7.25	2.70	0	0	0	0	0
302	5	910.0	0	7	15.00	5.20	5.40	10.00	2.60	0	0	0	0	0
303	5	910.0	0	7	17.00	4.50	4.75	7.70	3.35	0	0	0	0	0
304	5	910.0	0	7	16.65	3.90	3.90	8.35	1.90	0	0	0	0	0
305	5	910.0	0	7	16.45	3.70	3.70	8.20	1.50	0.	0	0	0	0
306	5	910.0	0	7	15.00	5.30	5.30	7.50	2.40	0	0	0	0	0
307	5	910.0	0	7	20.30	4.10	4.10	10.15	2.20	0	0	0	0	0
308	5	910.0	0	7	18.95	5.20	5.50	12.10	3.25	0	0	0	0	0
309	5	910.0	0	7	15.95	4.20	4.40	7.65	2.55	0	0	0	0	0
310	5	910.0	0	7	16.40	3.55	3.75	7.70	2.00	0	0	0	0	0
311	5	910.0	0	7	16.25	3.85	4.20	6.80	1.95	0	0	0	0	0
312	5	910.0	0	7	18.30	5.10	5.35	7.15	2.95	0	0	0	0	0
313	5	910.0	0	7	17.75	5.50	5.50	8.85	2.85	0	0	0	0	0
314	5	910.0	0	7	14.90	4.50	4.75	6.50	3.45	0	0	0	0	0
315	5	910.0	0	7	14.30	3.90	4.10	6.65	1.80	0	0	0	0	0
316	5	910.0	0	7	18.00	4.40	4.50	9.85	2.30	0	0	0	0	0
317	5	910.0	0	7	17.15	5.05	5.30	8.50	2.80	0	0	0	0	0
318	5	910.0	0	7	15.65	3.00	3.15	6.95	1.80	0	0	0	0	0
319	5	910.0	0	7	13.00	3.20	3.40	6.20	1.60	0	0	0	0	0
320	5	910.0	0	12	24.20	6.10	6.55	14.20	2.65	0	0	0	0	0
321	5	910.0	0	12	21.95	8.70	9.00	9.20	2.85	0	0	0	0	0
322	5	910.0	0	12	21.20	8.20	6.60	10.25	3.30	0	0	0	0	0

Table E-1. Lunate Raw Data. (12)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
323	5	910.0	0	12	26.90	9.40	9.40	13.40	2.10	0	0	0	0	0
324	5	910.0	0	12	21.55	7.90	7.95	9.60	2.55	0	0	0	0	0
325	5	910.0	0	12	25.65	9.10	9.10	12.60	3.40	0	0	0	0	0
326	5	910.0	0	12	18.70	7.60	8.05	6.35	2.15	0	0	0	0	0
327	5	910.0	0	12	18.80	6.20	6.20	9.40	1.65	0	0	0	0	0
328	5	910.0	0	12	23.50	9.20	9.60	10.75	2.95	0	0	0	0	0
329	5	910.0	0	12	18.60	5.95	5.95	9.30	2.00	0	0	0	0	0
330	5	910.0	0	12	19.95	5.80	5.80	9.95	1.75	0	0	0	0	0
331	5	910.0	0	12	25.10	5.30	5.70	7.45	3.25	0	0	0	0	0
332	5	910.0	0	12	19.00	8.20	8.65	10.65	2.50	0	0	0	0	0
333	5	910.0	0	12	22.40	6.95	7.55	14.30	2.70	0	0	0	0	0
334	5	910.0	0	12	26.85	9.75	9.80	8.70	3.75	0	0	0	0	0
335	5	910.0	0	12	33.30	9.25	9.25	16.65	2.90	0	0	0	0	0
336	5	910.0	0	12	18.20	4.80	4.80	9.10	1.40	0	0	0	0	0
337	5	910.0	0	12	25.45	9.30	9.40	15.00	4.20	0	0	0	0	0
338	5	910.0	0	12	24.00	9.40	10.10	13.05	1.90	0	0	0	0	0
339	5	910.0	0	12	20.85	8.00	8.00	10.40	3.60	0	0	0	0	0
340	5	910.0	0	12	21.30	9.60	9.70	10.25	2.30	0	0	0	0	0
341	5	910.0	0	12	19.00	6.00	6.00	9.50	2.10	0	0	0	0	0
342	5	910.0	0	12	15.20	5.95	5.95	7.60	2.90	0	0	0	0	0
343	5	910.0	0	12	19.90	5.40	5.70	8.20	2.00	0	0	0	0	0
344	5	910.0	0	12	20.90	6.60	6.60	10.45	2.30	0	0	0	0	0
345	5	910.0	0	12	22.00	6.60	7.00	9.60	2.90	0	0	0	0	0
346	5	910.0	0	12	24.00	5.65	5.65	12.00	2.90	0	0	0	0	0
347	5	910.0	0	12	19.80	9.60	9.85	8.20	2.20	0	0	0	0	0
348	5	910.0	0	12	18.15	4.60	4.60	9.10	1.65	0	0	0	0	0
349	5	910.0	0	1	31.60	11.00	11.45	13.60	2.20	0	0	0	0	0
350	5	910.0	0	1	32.60	10.10	10.10	16.30	3.40	0	0	0	0	0
351	5	910.0	0	1	25.90	6.85	6.85	12.95	2.85	0	0	0	0	0
352	5	910.0	0	7	25.35	7.95	8.10	13.95	4.70	0	0	0	0	0
353	5	910.0	0	11	36.10	9.55	9.55	18.00	5.2[illegible]	0	0	0	0	0
354	5	910.0	0	12	27.80	10.00	10.00	13.90	3.0[illegible]	0	0	0	0	0
355	5	910.0	0	12	26.25	7.00	7.55	11.10	2.25	0	0	0	0	0
356	5	910.0	0	12	27.15	6.95	7.25	15.80	2.20	0	0	0	0	0
357	5	910.0	0	12	27.75	8.55	8.55	13.85	1.45	0	0	0	0	0
358	5	910.0	0	12	28.15	9.15	9.15	14.00	2.95	0	0	0	0	0
359	5	910.0	0	12	26.50	7.20	7.50	10.65	2.20	0	0	0	0	0
360	5	910.0	0	12	27.80	8.40	6.45	12.95	2.85	0	0	0	0	0
361	5	910.0	0	12	24.00	9.25	9.25	12.00	3.60	0	0	0	0	0
362	5	910.0	0	12	33.95	7.85	6.00	12.40	3.00	0	0	0	0	0
363	5	910.0	0	12	29.85	9.95	10.15	12.90	2.60	0	0	0	0	0
364	5	910.0	0	12	27.20	6.60	6.95	17.30	3.15	0	0	0	0	0
365	5	910.0	0	12	25.50	6.40	6.80	15.60	2.10	0	0	0	0	0
366	5	910.0	0	12	31.00	7.20	7.20	15.50	2.60	0	0	0	0	0
367	5	910.0	0	12	32.30	6.55	7.60	20.45	2.60	0	0	0	0	0
467	5	911.0	0	12	27.50	6.20	6.40	16.70	2.30	0	0	0	0	0

Table E-1. Lunate Raw Data. (13)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
468	5	911.0	0	1	19.50	5.70	6.00	9.60	2.60	0	0	0	0	0
469	5	911.0	0	1	20.90	7.25	7.30	9.00	2.40	0	0	0	0	0
470	5	911.0	0	1	22.50	5.70	6.20	6.40	2.70	0	0	0	0	0
471	5	911.0	0	1	18.10	6.20	6.20	9.10	2.00	0	0	0	0	0
472	5	911.0	0	1	19.40	6.45	6.75	10.60	1.80	0	0	0	0	0
473	5	911.0	0	7	18.10	4.80	5.05	7.00	3.00	0	0	0	0	0
474	5	911.0	0	7	21.75	5.10	5.25	9.50	2.45	0	0	0	0	0
475	5	911.0	0	12	22.50	5.75	5.85	10.00	2.20	0	0	0	0	0
476	5	911.0	0	12	28.70	9.60	9.80	15.50	3.65	0	0	0	0	0
477	5	911.0	0	12	22.25	6.70	6.70	11.10	2.10	0	0	0	0	0
478	5	911.0	0	12	28.50	9.45	9.45	14.25	2.65	0	0	0	0	0
479	5	911.0	0	12	29.85	7.70	8.25	12.20	4.05	0	0	0	0	0
480	5	911.0	0	12	20.00	7.20	7.30	12.35	2.50	0	0	0	0	0
481	5	911.0	0	12	19.40	7.30	7.30	9.70	2.50	0	0	0	0	0
482	5	911.0	0	12	25.00	5.15	5.30	13.90	2.90	0	0	0	0	0
483	5	911.0	0	12	26.10	7.70	7.80	8.20	2.10	0	0	0	0	0
484	5	911.0	0	1	14.70	4.25	4.25	7.35	1.90	0	0	0	0	0
485	5	911.0	0	1	23.20	5.80	5.80	11.60	1.90	0	0	0	0	0
486	5	911.0	0	1	15.00	4.25	4.55	6.90	1.95	0	0	0	0	0
487	5	911.0	0	7	16.85	4.65	4.65	8.40	3.10	0	0	0	0	0
488	5	911.0	0	12	19.75	6.45	6.70	10.25	2.60	0	0	0	0	0
489	5	911.0	0	12	27.10	6.70	6.70	13.55	2.55	0	0	0	0	0
490	5	911.0	0	12	22.90	7.40	7.40	11.40	2.95	0	0	0	0	0
491	5	911.0	0	12	23.00	7.10	7.30	15.75	3.00	0	0	0	0	0
492	5	911.0	0	1	17.65	7.35	7.35	8.80	4.00	0	0	0	0	0
493	5	911.0	0	1	20.40	8.55	8.65	10.60	3.55	0	0	0	0	0
494	5	911.0	0	1	21.55	7.65	8.10	13.80	2.95	0	0	0	0	0
495	5	911.0	0	1	21.75	8.40	8.40	10.65	1.75	0	0	0	0	0
496	5	911.0	0	1	19.70	6.60	6.60	9.60	3.00	0	0	0	0	0
497	5	911.0	0	1	18.30	5.50	5.90	10.75	2.40	0	0	0	0	0
498	5	911.0	0	1	14.30	4.95	4.95	7.15	1.65	0	0	0	0	0
499	5	911.0	0	1	26.70	9.60	9.60	13.35	2.95	0	0	0	0	0
500	5	911.0	0	1	25.65	5.90	6.10	17.75	2.00	0	0	0	0	0
501	5	911.0	0	1	17.00	4.85	4.85	8.50	2.50	0	0	0	0	0
502	5	911.0	0	1	13.10	3.85	4.00	7.30	1.65	0	0	0	0	0
503	5	911.0	0	1	16.90	4.65	4.65	8.45	2.00	0	0	0	0	0
504	5	911.0	0	1	13.60	4.80	5.10	6.30	1.80	0	0	0	0	0
505	5	911.0	0	1	17.35	5.25	5.25	8.65	2.00	0	0	0	0	0
506	5	911.0	0	1	17.15	4.15	4.20	6.90	1.65	0	0	0	0	0
507	5	911.0	0	1	13.50	4.35	4.55	9.20	2.15	0	0	0	0	0
508	5	911.0	0	1	14.70	4.85	4.85	7.35	1.65	0	0	0	0	0
509	5	911.0	0	1	18.20	5.10	5.10	9.10	1.90	0	0	0	0	0
510	5	911.0	0	1	16.80	4.80	5.00	7.75	2.00	0	0	0	0	0
511	5	911.0	0	1	18.00	4.60	4.85	10.90	1.80	0	0	0	0	0
512	5	911.0	0	1	13.80	4.40	4.70	6.40	2.00	0	0	0	0	0
513	5	911.0	0	1	13.90	3.45	3.45	6.95	1.50	0	0	0	0	0

Table E-1. Lunate Raw Data. (14)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
514	5	911.0	0	1	14.05	4.00	4.00	7.00	1.65	0	0	0	0	0
515	5	911.0	0	1	18.30	5.10	5.10	9.20	1.60	0	0	0	0	0
516	5	911.0	0	1	15.10	4.50	4.60	6.20	1.50	0	0	0	0	0
517	5	911.0	0	1	15.45	5.30	5.55	8.60	1.95	0	0	0	0	0
518	5	911.0	0	12	22.50	7.45	7.75	10.10	3.60	0	0	0	0	0
519	5	911.0	0	12	26.35	9.10	9.35	15.60	3.55	0	0	0	0	0
520	5	911.0	0	12	25.20	10.60	10.60	12.60	3.40	0	0	0	0	0
521	5	911.0	0	12	26.95	7.30	7.30	13.45	2.20	0	0	0	0	0
522	5	911.0	0	12	26.40	7.50	7.60	16.60	2.60	0	0	0	0	0
523	5	911.0	0	12	20.50	9.15	9.60	6.30	3.65	0	0	0	0	0
524	5	911.0	0	12	31.50	9.50	9.50	15.60	2.90	0	0	0	0	0
525	5	911.0	0	12	24.50	8.75	8.75	12.20	3.10	0	0	0	0	0
526	5	911.0	0	12	20.50	8.05	8.20	13.40	2.30	0	0	0	0	0
527	5	911.0	0	12	16.80	7.00	7.00	8.40	2.00	0	0	0	0	0
528	5	911.0	0	7	15.10	4.10	4.40	8.60	2.10	0	0	0	0	0
529	5	911.0	0	7	17.60	5.00	5.25	11.90	2.45	0	0	0	0	0
530	5	911.0	0	7	13.60	4.50	4.50	6.80	2.00	0	0	0	0	0
531	5	911.0	0	7	15.20	4.10	4.20	10.50	1.65	0	0	0	0	0
532	5	911.0	0	7	15.65	4.80	4.80	7.80	2.60	0	0	0	0	0
533	5	911.0	0	7	22.30	7.90	8.00	12.60	3.30	0	0	0	0	0
534	5	911.0	0	7	18.80	5.50	5.90	7.60	2.40	0	0	0	0	0
535	5	911.0	0	7	16.10	3.70	4.30	4.90	2.10	0	0	0	0	0
536	5	911.0	0	7	14.75	3.20	3.20	7.35	1.95	0	0	0	0	0
537	5	911.0	0	7	15.80	4.45	4.45	7.60	2.00	0	0	0	0	0
538	5	911.0	0	7	19.40	4.80	4.80	9.70	3.10	0	0	0	0	0
539	5	911.0	0	7	15.10	4.00	4.10	6.50	2.45	0	0	0	0	0
540	5	911.0	0	7	16.45	6.20	6.20	8.20	2.25	0	0	0	0	0
541	5	911.0	0	7	14.00	4.00	4.00	7.00	2.10	0	0	0	0	0
542	5	911.0	0	7	15.90	3.45	3.60	6.80	2.55	0	0	0	0	0
543	5	911.0	0	7	22.60	5.65	6.00	14.00	3.40	0	0	0	0	0
544	5	911.0	0	7	15.00	3.70	3.80	7.60	2.50	0	0	0	0	0
545	5	911.0	0	7	14.70	4.90	4.90	7.40	2.80	0	0	0	0	0
546	5	911.0	0	7	15.80	4.70	4.90	9.60	1.80	0	0	0	0	0
547	5	911.0	0	7	17.00	4.50	4.50	8.50	2.20	0	0	0	0	0
548	5	911.0	0	7	14.00	4.40	4.40	7.00	2.20	0	0	0	0	0
549	5	911.0	0	7	14.50	3.95	3.95	7.25	2.70	0	0	0	0	0
550	5	911.0	0	7	14.20	4.45	4.50	8.10	2.15	0	0	0	0	0
368	6	920.0	0	1	18.50	4.50	4.50	9.30	1.60	0	0	0	0	0
369	6	920.0	0	7	17.60	4.50	4.60	11.25	2.00	0	0	0	0	0
370	6	920.0	0	7	17.40	4.40	4.60	11.45	2.15	0	0	0	0	0
371	6	920.0	0	7	12.95	3.50	3.95	6.50	1.90	0	0	0	0	0
372	6	921.0	0	1	16.85	4.35	4.50	9.10	1.50	0	0	0	0	0
373	6	921.0	0	1	16.10	4.45	5.00	7.75	1.40	0	0	0	0	0
374	6	921.0	0	1	16.85	3.90	3.90	8.40	1.30	0	0	0	0	0
375	6	921.0	0	1	14.65	3.90	4.10	6.60	1.90	0	0	0	0	0
376	6	921.0	0	7	13.50	3.85	4.00	5.65	1.95	0	0	0	0	0

Table E-1. Lunate Raw Data. (15)

NO	S	L	FN	R	LEN	MWID	NWID	LTWW	TH	U	D	M	T	P
377	6	921.0	0	7	10.00	3.75	3.75	5.00	2.45	0	0	0	0	0
378	6	921.0	0	7	11.00	3.60	3.60	7.10	1.65	0	0	0	0	0
379	6	921.0	0	7	16.40	4.20	4.20	6.20	1.95	0	0	0	0	0
380	6	921.0	0	7	11.50	3.60	3.80	5.80	1.60	0	0	0	0	0
381	6	921.0	0	7	9.75	3.20	3.20	4.85	1.90	0	0	0	0	0
382	6	921.0	0	7	20.10	5.25	5.25	10.00	2.45	0	0	0	0	0
383	6	921.0	0	7	19.30	4.50	4.90	9.00	2.10	0	0	0	0	0
384	6	921.0	0	7	15.00	4.00	4.00	7.50	3.05	0	0	0	0	0
385	6	921.0	0	7	12.00	3.15	3.15	6.00	1.90	0	0	0	0	0
386	6	921.0	0	7	11.80	4.00	4.00	5.90	2.45	0	0	0	0	0
387	6	921.0	0	7	9.80	3.45	3.70	3.60	2.55	0	0	0	0	0
388	6	921.0	0	1	16.30	4.00	4.00	8.15	2.15	0	0	0	0	0
389	6	921.0	0	1	17.55	4.45	5.30	5.15	1.85	0	0	0	0	0
390	6	921.0	0	1	15.00	3.60	3.65	7.90	1.75	0	0	0	0	0
391	6	921.0	0	1	17.60	4.45	4.65	10.30	2.25	0	0	0	0	0
392	6	921.0	0	7	22.85	6.55	6.55	11.40	2.85	0	0	0	0	0
393	6	921.0	0	7	18.50	3.60	4.00	8.10	2.30	0	0	0	0	0
394	6	921.0	0	1	17.85	5.10	5.50	10.15	2.10	0	0	0	0	0
395	6	921.0	0	1	16.10	4.35	4.55	6.30	1.30	0	0	0	0	0
396	6	921.0	0	1	13.85	4.25	4.25	6.90	1.35	0	0	0	0	0
397	6	921.0	0	1	17.40	3.80	4.00	6.05	2.30	0	0	0	0	0
398	6	921.0	0	1	17.25	4.10	4.10	8.65	1.50	0	0	0	0	0
399	6	921.0	0	1	14.45	4.00	4.30	6.25	1.40	0	0	0	0	0
400	6	921.0	0	7	16.95	3.85	3.85	8.45	2.40	0	0	0	0	0
401	6	921.0	0	7	16.35	3.85	3.65	8.15	2.00	0	0	0	0	0
402	6	921.0	0	7	20.85	4.00	4.00	10.40	2.65	0	0	0	0	0
403	6	921.0	0	7	17.75	3.40	3.45	7.85	2.00	0	0	0	0	0
404	6	921.0	0	7	12.80	3.50	3.50	6.40	1.55	0	0	0	0	0
405	6	921.0	0	7	23.25	7.55	7.80	9.30	4.20	0	0	0	0	0
406	6	922.0	0	1	16.30	5.00	5.40	9.40	2.55	0	0	0	0	0
407	6	922.0	0	1	17.80	4.40	4.85	10.55	2.50	0	0	0	0	0
406	6	922.0	0	1	17.05	3.90	3.90	8.50	2.00	0	0	0	0	0
409	6	922.0	0	1	11.80	3.90	3.90	5.90	2.80	0	0	0	0	0
410	6	922.0	0	7	14.65	4.10	4.10	7.40	2.10	0	0	0	0	0
411	6	922.0	0	7	12.60	3.70	3.95	6.40	2.40	0	0	0	0	0
412	6	922.0	0	1	17.65	4.40	4.40	8.80	1.65	0	0	0	0	0
413	6	922.0	0	7	15.90	3.90	4.45	7.40	2.30	0	0	0	0	0
414	6	923.0	0	1	14.20	3.75	3.75	7.10	2.45	0	0	0	0	0
415	6	923.0	0	7	16.50	4.30	4.30	8.25	2.65	0	0	0	0	0
416	6	923.0	0	1	20.20	5.20	5.55	12.20	2.15	0	0	0	0	0
417	6	923.0	0	1	14.65	4.55	4.55	7.30	2.25	0	0	0	0	0
418	6	923.0	0	1	14.60	4.95	4.95	7.30	1.65	0	0	0	0	0
419	6	923.0	0	1	13.00	3.80	3.90	7.10	2.85	0	0	0	0	0
420	6	923.0	0	7	15.80	4.45	4.70	5.90	2.40	0	0	0	0	0
421	6	923.0	0	7	14.55	4.95	5.00	6.80	2.30	0	0	0	0	0
422	6	922.0	0	1	17.20	4.25	4.50	10.75	1.80	0	0	0	0	0

Table E-1. Lunate Raw Data. (16)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	D	M	T	P
423	6	922.0	0	1	12.75	3.55	3.60	5.60	1.50	0	0	0	0	0
424	6	922.0	0	7	17.65	5.15	5.50	10.65	2.40	0	0	0	0	0
425	6	922.0	0	7	17.80	6.20	6.50	10.45	3.65	0	0	0	0	0
426	6	922.0	0	7	14.95	4.40	4.40	7.45	2.30	0	0	0	0	0
427	6	922.0	0	1	17.15	3.85	4.00	6.90	2.35	0	0	0	0	0
428	6	922.0	0	1	15.75	4.25	4.50	6.70	2.45	0	0	0	0	0
429	6	924.0	0	1	16.30	3.65	4.15	6.60	1.50	0	0	0	0	0
430	6	924.0	0	1	16.75	3.90	4.20	10.10	1.95	0	0	0	0	0
431	6	924.0	0	1	19.00	4.40	4.50	10.60	1.65	0	0	0	0	0
432	6	924.0	0	1	15.20	4.55	4.55	7.65	2.40	0	0	0	0	0
433	6	924.0	0	1	9.30	2.95	3.10	3.50	1.45	0	0	0	0	0
434	6	924.0	0	7	8.95	3.10	3.25	3.95	2.25	0	0	0	0	0
435	6	924.0	0	7	30.35	7.25	7.25	15.10	3.65	0	0	0	0	0
436	6	924.0	0	7	19.00	4.35	4.35	9.45	2.60	0	0	0	0	0
437	6	924.0	0	7	17.50	3.80	3.80	8.75	2.20	0	0	0	0	0
438	6	924.0	0	7	15.10	6.20	6.20	7.55	3.10	0	0	0	0	0
439	6	924.0	0	7	16.35	3.40	3.45	9.00	2.60	0	0	0	0	0
440	6	924.0	0	7	15.50	4.10	4.10	7.75	2.55	0	0	0	0	0
441	6	924.0	0	7	14.00	3.55	3.90	6.80	1.70	0	0	0	0	0
442	6	924.0	0	7	14.15	3.70	3.70	7.05	2.80	0	0	0	0	0
443	6	924.0	0	7	14.25	3.20	3.30	6.10	1.95	0	0	0	0	0
444	6	924.0	0	7	16.20	3.60	3.60	8.20	2.75	0	0	0	0	0
445	6	924.0	0	7	16.55	4.35	4.35	8.20	1.85	0	0	0	0	0
446	6	924.0	0	7	14.20	4.00	4.00	7.10	2.10	0	0	0	0	0
447	6	924.0	0	7	12.40	3.60	3.70	6.50	1.95	0	0	0	0	0
448	6	924.0	0	7	11.10	4.00	4.00	5.65	1.75	0	0	0	0	0
449	6	924.0	0	7	17.35	4.10	4.10	8.65	2.25	0	0	0	0	0
450	6	924.0	0	7	15.00	3.95	4.10	8.85	1.65	0	0	0	0	0
451	6	924.0	0	1	10.20	3.20	3.20	5.10	2.10	0	0	0	0	0
452	6	924.0	0	7	16.70	3.20	3.20	8.35	1.90	0	0	0	0	0
453	6	924.0	0	1	15.20	3.30	3.70	5.70	1.75	0	0	0	0	0
454	6	924.0	0	1	18.20	6.70	7.10	10.65	1.95	0	0	0	0	0
455	6	924.0	0	12	25.60	6.00	6.40	9.20	2.20	0	0	0	0	0
456	6	924.0	0	1	16.35	4.95	4.95	8.15	3.10	0	0	0	0	0
457	6	924.0	0	1	15.70	3.60	3.75	9.15	1.65	0	0	0	0	0
458	6	924.0	0	1	16.80	4.45	4.45	8.40	1.55	0	0	0	0	0
459	6	924.0	0	1	16.30	4.00	4.25	6.40	2.30	0	0	0	0	0
460	6	924.0	0	1	18.10	4.00	4.00	9.00	1.60	0	0	0	0	0
461	6	924.0	0	1	13.85	4.45	4.45	6.90	3.30	0	0	0	0	0
462	6	924.0	0	1	14.45	3.65	3.65	7.30	1.75	0	0	0	0	0
463	6	924.0	0	7	18.80	4.25	4.40	11.25	2.65	0	0	0	0	0
464	6	924.0	0	7	16.35	4.40	4.45	7.80	2.40	0	0	0	0	0
465	6	924.0	0	7	14.25	3.40	3.55	7.95	1.45	0	0	0	0	0
466	6	924.0	0	7	11.80	4.10	4.10	5.90	2.10	0	0	0	0	0
551	7	930.0	0	1	17.20	6.05	6.40	9.20	2.20	0	0	0	0	0
552	7	930.0	0	1	22.95	5.80	5.80	11.50	1.75	0	0	0	0	0

Table E-1. Lunate Raw Data. (17)

NO	S	L	FN	R	LEN	MWID	WWID	LTWW	TH	U	O	M	T	P
553	7	930.0	0	1	21.35	8.70	8.70	10.65	2.10	0	0	0	0	0
554	7	930.0	0	1	20.75	6.45	6.50	12.55	1.70	0	0	0	0	0
555	7	930.0	0	1	21.15	4.90	4.90	10.50	2.00	0	0	0	0	0
556	7	930.0	0	1	17.60	5.80	5.80	8.80	3.30	0	0	0	0	0
557	7	930.0	0	11	20.95	7.10	7.10	10.50	2.60	0	0	0	0	0
558	7	930.0	0	4	21.70	7.00	7.80	9.25	2.70	0	0	0	0	0
559	7	930.0	0	7	20.65	5.90	6.10	11.60	3.30	0	0	0	0	0
560	7	930.0	0	7	17.55	4.90	5.00	8.80	3.40	0	0	0	0	0
561	7	930.0	0	7	17.40	4.90	5.00	10.15	2.05	0	0	0	0	0
562	7	930.0	0	7	21.20	8.20	8.20	10.60	3.05	0	0	0	0	0
563	7	930.0	0	7	17.70	5.75	5.75	8.80	3.10	0	0	0	0	0
564	7	930.0	0	7	19.85	5.65	5.65	9.90	2.75	0	0	0	0	0
565	7	930.0	0	12	27.00	8.85	8.85	13.50	2.70	0	0	0	0	0
566	7	930.0	0	12	17.90	5.80	5.80	8.95	3.35	0	0	0	0	0
567	7	930.0	0	12	22.00	8.75	8.75	11.00	2.20	0	0	0	0	0
568	7	930.0	0	12	23.85	10.10	10.20	13.10	3.10	0	0	0	0	0
569	7	930.0	0	12	23.50	8.10	8.10	11.75	2.30	0	0	0	0	0
570	7	930.0	0	12	27.55	9.75	9.75	13.70	3.40	0	0	0	0	0
571	7	930.0	0	12	24.90	8.20	8.80	10.90	3.00	0	0	0	0	0
572	7	930.0	0	12	20.55	7.45	7.60	8.70	2.40	0	0	0	0	0
573	7	930.0	0	12	30.30	10.10	10.10	15.15	3.00	0	0	0	0	0
574	7	930.0	0	12	28.50	10.80	10.80	14.25	3.65	0	0	0	0	0
575	7	930.0	0	12	28.80	9.35	9.35	14.40	4.10	0	0	0	0	0
576	7	930.0	0	12	30.50	8.95	8.95	15.25	3.65	0	0	0	0	0
577	7	930.0	0	12	24.80	8.30	8.30	12.40	1.85	0	0	0	0	0
578	7	930.0	0	12	21.10	5.25	5.25	10.55	2.40	0	0	0	0	0
579	7	930.0	0	12	23.30	7.00	7.00	11.65	2.85	0	0	0	0	0
580	7	930.0	0	12	21.10	7.25	7.25	10.60	2.90	0	0	0	0	0
581	7	930.0	0	12	23.20	9.70	9.85	12.50	2.20	0	0	0	0	0
582	7	930.0	0	12	25.80	7.65	7.65	12.90	2.45	0	0	0	0	0
583	7	930.0	0	12	25.20	7.65	7.65	12.55	2.65	0	0	0	0	0
584	7	930.0	0	12	24.10	7.35	7.50	13.10	2.00	0	0	0	0	0
585	7	930.0	0	12	20.20	6.55	6.55	10.15	2.25	0	0	0	0	0
586	7	930.0	0	12	19.30	6.70	6.70	9.65	2.00	0	0	0	0	0
587	7	930.0	0	12	18.80	7.00	7.00	9.40	2.80	0	0	0	0	0
588	7	930.0	0	12	31.20	8.45	8.45	15.60	2.60	0	0	0	0	0
589	7	930.0	0	12	33.45	10.55	10.55	16.70	3.95	0	0	0	0	0
590	7	930.0	0	12	30.40	9.00	9.00	15.20	3.50	0	0	0	0	0
591	7	930.0	0	12	26.00	7.50	7.50	13.00	3.30	0	0	0	0	0
592	7	930.0	0	12	26.75	9.00	9.00	13.30	3.30	0	0	0	0	0
593	7	930.0	0	12	27.30	8.00	8.00	13.60	3.35	0	0	0	0	0
594	7	930.0	0	12	25.50	8.10	8.10	12.75	2.50	0	0	0	0	0
595	7	930.0	0	12	26.50	9.20	9.20	13.20	2.35	0	0	0	0	0
596	7	930.0	0	12	26.35	8.95	8.95	13.20	2.45	0	0	0	0	0
597	7	930.0	0	12	24.30	8.30	8.30	12.20	4.30	0	0	0	0	0

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