RECONSTRUCTING MICROLITH SHAPING: 
ARCHAEOLOGICAL AND EXPERIMENTAL OBSERVATIONS 
OF EARLY AND FINAL NATUFIAN LUNATES AT EYNAN 
(AIN MALLAHA), ISRAEL

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Abstract

This study concerns lunates, the most typical geometric microliths of the Natufian period. Its results reveal clear contrasts in retouching methods and techniques between the Early and Final Natufian. In the Early Natufian, Holwan retouch and its variants were executed by the pressure technique and through a method by which each face of the object is successively modified. This very simple method results in lunates that are progressively shaped and retouched edges that remain relatively thin. The method used in the Final Natufian consists of two stages. First, a roughing-out sequence realized with a stone retoucher leads to a segmentation of the piece by the microburin procedure. In the second sequence, the roughout is meticulously regularized using the pressure technique on a support. These significant transformations between the Early and Final Natufian seem to be explained by the hypermicrolithization of these tools.

INTRODUCTION (B.V.)

Countless traditional typological studies have demonstrated the extreme variability of Upper Paleolithic and Epipaleolithic microliths. A combination of functional diversity (e.g., the kind of wound intended or hafting method), variable retouch procedures and the arbitrary nature of some morpho-dimensional choices (i.e., stylistic variability) make microliths an excellent source of evidence for recognizing technical identity (e.g., Sommerville-Bordes de, 1960; Escalon de Fonton, 1966; Copeland and Waechter, 1968; Bar-Yosef, 1970, 1976; Hours, 1976; Marks, 1976–1983; Bar-Yosef and Phillips, 1977; Rozoy, 1978; Thévenin, 1982). Over the past thirty years, numerous studies have demonstrated that debitage modes also changed and that this variability is more or less correlated with microlith diversity (e.g., Valentin, 1995; De Bie and Caspar, 2000; Ducrocq, 2001; Guilbert, 2001; Belfer-Cohen and Goring-Morris, 2002; Bon, 2002; Shimmelmitz, 2002; Klaric, 2003, Davidson and Goring-Morris, 2003; Marder, 2003; Souffi, 2004). This same technological approach has recently been applied to the study of artifact retouch, especially on microliths (e.g., Valentin, 1995; De Bie and Caspar, 2000; Klaric et al., 2002; Christensen and Valentin, 2004; Chensaux, 2004). In addition to describing the main procedures used in retouching (e.g., the well-known microburin technique), the challenge is to precisely reconstruct the successive stages of blank transformation, as well as the implements used in the retouching procedure. In these ways, different aspects of retouched edges, such as regularity or degree of obliquity, which were already emphasized by traditional typology,
can be interpreted. Most importantly, this is the
most effective way to precisely recognize the
main concepts (or “mental images” Pelegrin,
1995:29) that guided toolmakers during the
manufacturing of microliths whose final morphol-
yogy was limited to a few main forms. It is then
possible to discover that some morphological
convergences actually mask a high diversity, not
only in manufacturing procedures, but also in fi-
nal goals. For example, during the Late Mag-
dalenian in the Paris Basin (France), the large
category of backed bladelets that at first appear to
be very homogeneous, actually show a high de-
gree of variability (in the standardization of final
dimensions, the straightness of the profile and the
straightness of the cutting edge), which is proba-
bly related to a chronological evolution (Chris-
tensen and Valentin, 2004).

A technological approach to the study of mi-
croliths thus contributes to the development of a
subtle typology that takes into account more de-
tails, and especially more discrete details, which
sometimes constitute the main hallmark of cul-
tural identity. In other words, technological anal-
yses allow us to organize traditional typological
attributes into a hierarchy that reflects the organi-
sation of prehistoric choices. When combined
with microwear analysis, this approach allows us
to analyze the functional needs related to these
attributes (e.g., Finlayson and Mithen, 1997; De Be
caspar, 2000; Crombé et al., 2001; Philibert,
2002; Christensen and Valentin, 2004; Chesa-
aux, 2004; Plisson, in press; Valentin, in press), since
these specific needs could be also an integral ele-
ment of the choices that characterize social iden-
tity.

Though this approach is quite promising, it is
not without difficulties. It is almost commonplace
to point out that the primary source of difficulty is
related to the scale of observation. Reconstructing
the fabrication procedures of very small artifacts
requires close attention to minute details. Conse-
quently, the technological “reading” required by
this type of analysis is much more detailed than
that generally applied to the analysis of debitage
products. This probably explains why most re-
searchers stick to analyzing knapping methods,
for which they can also benefit from refittings,
which are nearly impossible with microliths.

The main element of this analysis thus con-
sists of comparing finished microliths (end-
products) and microliths discarded during manu-
facture. However, distinguishing between unfin-
nished microliths and simplified finished products
is not always evident. Here again, microwear
analysis can be useful since microliths bearing
impact damage can be identified as definite fin-
ished products. The other main difficulty involves
the reconstruction of retouching techniques, for
which it is absolutely necessary to painstakingly
create experimental reference collections that
allow us to establish correspondences between ret-
ouch characteristics and the tools used to produce
them. Such reference bases are similar to the ones
developed some time ago for the analysis of
debitage techniques (Pelegrin, 1991, 2000). Ref-
ence collections concerning retouching tech-
niques are currently being created and have al-
ready revealed that the characteristics of some
retouching techniques can be highly ambiguous
(Pelegrin, 2004). Although this same kind of am-
biguity was encountered in debitage analysis, ret-
ouch analysis adds the problems of the scale of ob-
ervation – the smaller the size, the higher the risk
of confusion.

The study we present here was inspired by
these diverse methodological issues. The main
objective of our analyses was to refine the typol-
ogy of some well-known Epipaleolithic microl-
liths from the Southern Levant. Since we encoun-
tered all the difficulties described above, it was
conceived in an almost didactic spirit. This study
undoubtedly constitutes only a prefiguration for a
broader program, which will consider a wider
range of typological and cultural diversity. Here,
we intentionally limited ourselves to geometric
microliths of the Natufian culture, namely lunate
and triangles.

WHY CONCENTRATE ON NATUFIAN
GEOMETRIC MICROLITHS? (F.V.)

The Levantine sequence of Epipaleolithic indus-
tries offers a wide range of non geometric and
geometric microliths characterized by differences
in final shape and size, as well as in blank produc-
tion techniques and retouch procedures (see for
examples Bar-Yosef, 1970; Besançon et al.,
1975–1977; Goring-Morris, 1987). This diversity
provides many possible case studies for research
on changing retouch procedures through time and space and geometric microliths of the Natufian culture are only one possibility. One could thus ask why we chose to focus on Natufian microliths. In addition to the occasional stimulus provided by ongoing excavations at Eynan (Ain Mallaha; Fig. 1), Natufian geometric microliths appear to be an attractive example because of the relatively spectacular changes in retouch characteristics, and because of the possible interaction of other characteristics — including size — in the process of changing retouching methods. As far as we know, the famous bifacial retouch known as “Helwan retouch”, typical of this culture, was never studied in detail and its understanding could therefore be seen as an appealing challenge.

Moreover, since the discovery of the Natufian culture at Shukba Cave by Dorothy Garrod in 1928, retouch modification on microliths and other tools has been central in discussions of this cultural entity. Even superficial observations revealed that tools similar in general shape, mainly lunates and “sickle blades”, may result from retouch that is very different in its final characteristics. Some edges bear removal scars on only one face, usually the dorsal face with arisses (direct retouch), but sometimes on the flat ventral face (inverse retouch). Direct and inverse removals may also be successively associated at different places on the same edge (alternating retouch). In some cases, direct, inverse or alternating removals are more or less perpendicular to blank faces.

![Fig. 1](image1.png) Location of Eynan and Natufian on Ramonian sites mentioned in the text

Whenever direct and inverse removals of this kind are opposed on the same part of the edge one speaks of “crossed retouch” (Itzian et al., 1992), also known as “bipolar retouch”. Each of these

![Fig. 2](image2.png) Schematic stratigraphy from East to West at Eynan (from Perrot J., Ladiray D., Soliveres-Massei D. 1988, *Les Hommes de Mallaha (Eynan) Israel*. Association Paléorient, fig. 4 with modifications)
kinds of blank modification is commonly observed on late Epipaleolithic flint tools, but some Natufian assemblages also include a rare sort of oblique retouch on both faces of the object called "Helwan" retouch (see below). In combination with the length of geometric microliths (mainly lunes), and with the few stratified Natufian deposits available, together with some radiometric controls, these differences were used by most researchers as key indicators for chronological segregation purposes. However, the main focus was on the morphological aspects of the retouch while little attention was paid to the processes by which they were created. The time now seems ripe for a more in-depth analysis capable of detecting the procedures behind superficially observed differences. This analysis may reinforce the value instinctively granted to these differences by exploring to what extent the procedures behind them imply different approaches to the blanks in view of the desired endproduct. We focus our work on lunate samples from the Early and Final Natufian deposits of Eynan (Fig. 2). A study of microliths from the beginning and end of the sequence, which thus emphasizes contrasts, should contribute to understanding the modifications that occurred in the "mental image" of the desired tools during the Natufian period. It should also allow us to explore possible links between this "mental image" and obvious changes in retouch characteristics.

BRIEF HISTORY OF RESEARCH
Helwan retouch: identification and chronological meaning

What we know as "Helwan" retouch was described in the Levant by D.A.E. Garrod following her excavations at el-Wad beginning in 1929. She writes of "lunates and other microliths" showing a peculiar retouch: "the back of the implement is not blunted in the ordinary way, but is trimmed obliquely from both surfaces, the result being sharp instead of blunt." (1932:261). The same retouch is mentioned by Neuvillé who observes as typical for his Natufian I, "a small crescent, around 3 cm long, with an arched edge thinned by flat removals on both faces" (1934:15 from the offprint - our translation). As early as 1932, Garrod noted that lunates shaped with this kind of retouch, from the Egyptian site of Helwan, had already been published by J. de Morgan (de Morgan, 1926:68s). However, only in her final publication of the work at the Wadi Mughara does she associate the name of the Egyptian site with this specific kind of retouch, "(Lunes) fall into two groups, one containing the ordinary blunted-back type common to the bulk of microlithic industries, the other a special form in which the back is not flat but is worked to a blunt edge by chipping on both faces. The latter type occurs at Helwan (sic) and is figured by de Morgan, and for convenience of reference I have called this type of retouch (which occurs also on other implements) the Helwan (sic) type." (Garrod and Bate, 1937: 30). To clarify further discussion, it may be helpful to quote Neuvillé's description of the lunates at Erq el-Ahmar (Early Natufian): "The microlithic crescent (...) consists of a thin bladelet with a rather rectilinear sharp edge opposed to a back that has been reshaped into a circular arch. This shaping is either abrupt and the piece is thus "backed", or oblique starting from the back and affecting either one face only, or more often, the two faces; in the latter case the back is tapered and forms an acute angle between the two faces of the piece. This latter type, whose retouch type is encountered on other pieces from this level, is characteristic of the Natufian I. Miss Garrod refers to this type of shaping as Helwan retouch." (Neuvillé, 1951:110–112 – our translation).

From these rather imprecise definitions we nonetheless see that, first, their authors called "Helwan retouch" a method of backing, and second, that for them the term Helwan was strictly restricted to this bifacial retouch type resulting in a sharp angle. The term "retouche en dos d'âne", sometimes used by Neuvillé, and its translation, "ridge-back retouch", proposed by Garrod (1957:214–215), are devoid of ambiguity. Significantly, Neuvillé clarifies that an oblique retouch worked from only one face of the blank does not fulfill the definition of Helwan retouch. This definition, coined by Garrod and Neuvillé, was accepted without modification by their successors.

Problems arose when doubts were expressed concerning the chronological significance of this retouch. Garrod believed that levels such as B2 at el-Wad, where lunates and sickle blades were pre-
dominantly of the Helwan type, should be described as Early Natufian, whereas levels where these types of lunate and sickle blades were either a minority (el-Wad B1), or virtually missing (Shubayqa), should be assigned to a second phase, which she termed Late Natufian. Neuville (1934) accepted this division with further elaboration. Based on the size of the lunates, he introduced a third stage. According to his observations, microlithic lunates became increasingly smaller through time. For him, the phase in which Helwan lunates predominated (Natufian I) was associated with relatively large lunates (ca. 3 cm, in length), whereas the following phase (Natufian II) had lunates seldom longer than 2 cm. His new Natufian III phase had even shorter lunates, 11 to 15 mm long, and no Helwan retouch at all. A fourth phase was also described but is of no interest to us since it includes arrowheads and is no longer considered Natufian.

In fact, some discrepancies already appeared in Neuville’s main work published in 1951. First, Neuville was not fully coherent with his own threelfold division when he attributed the Umm ez-Zuwetina material to his Natufian I despite a limited percentage of Helwan lunates. Second, he noticed that even Natufian I assemblages could have relatively small lunates: el-Wad B2 was an example. Third, el-Khiam, his type site for the third phase of the Natufian, appeared to be mixed and contained many arrow-heads (Perrot in Neuville, 1951). These difficulties, along with the then supposed stratigraphy at Eynan, in which no clear change in the lunates through three layers of building accumulated in a 2 m thick deposit was detected, induced Perrot (1968, col. 268f.) to dismiss the entire scheme.

At this stage of research, and due to the findings of Natufian entities in areas far from the Palestinian sites where the Natufian was first traced, mainly in the central Negev and the middle Euphrates Valley, a comprehensive revaluation became necessary (Kirkbride, 1966; Henry, 1976; Cauvin, 1980). The main goal was to verify the feasibility of a chronological seriation of Natufian sites over the entire area. From this perspective, careful attention was paid to sampling; whenever possible, samples should come from definite occupations, limited in space and time – admittedly a problematic issue due to extensive digging by Natufian builders. Moreover, samples should include all materials and be collected through appropriate sieving. Under these conditions, samples should be considered as representative of the assemblages of which they are a part, unless obvious admixture is observed. From this broad perspective, little interest was devoted to the stages of the retouching process. Instead, the products were subject to detailed examination as they were retrieved. The aim was not to elucidate the microprocesses of assemblage formation, but to examine the sums of processes considered to significantly reflect – at least at a statistical level – the activity of flint knappers at a given time and place in order to possibly include them in a seriation scheme.

The first question that needed to be addressed in order to check the old scheme was simple: what is a Helwan lunate? Neuville had already observed that lunates were not always backed along their whole length and that more than one kind of retouch could be associated on the same back. Valla’s (1975, 1984; Bar-Yosef and Valla, 1979) view was that any lunates bearing traces of oblique bifacial trimming should be considered as Helwan, whatever the length of the bifacial retouch on the modified edge. Unifacial retouch, either direct, inverse or alternating, and whatever its inclination (oblique, abrupt or vertical), should not be included in the Helwan group, nor should crossed retouch. This point of view seemed necessary to make relatively straightforward and meaningful comparisons.

Nevertheless, in his description of the Negev sites, Goring-Morris included what he called “Helwan sensu-stricto and inverse and alternate” (1987:295) (alternate being taken for alternating in the sense of Inizan et al., 1992) in the category of Helwan lunate. Another way of twisting the chronological meaning of the retouch was advocated by Sellars (1991:452) who suggested taking into account only the balance of Helwan to direct abrupt retouch in screening Early and Late Natufian industries.

**Why Helwan retouch?**

The problem of the kind of retouch and its distribution on the microlith seems to have implications beyond the chronological seriation of Na-
The microburin technique issue

It is not our intention to fully discuss the issue of the microburin technique in the Levant. According to current knowledge, this technique was used by microlith toolmakers in this area prior to 18,000 BP (Byrd, 1998:71). A quick description of the typical by-products is nonetheless needed in the context of our discussion. According to Tixier (1963:41), “A microburin presents, on its superior face, a portion of a notch with direct retouch and, on its inferior face, a “fracture facet” continuing from the deepest part of the notch portion to the opposite edge, forming an acute angle with it (the superior face).” The remaining object, with the scar of the oblique break, is called a “piquant-trièdre” (our translation). Microburins can be divided into three categories, proximal, distal and double, depending on the part of the blank they remove and the number of microburin scars they bear. Objects with these features were remarked by prehistorians at the end of the nineteenth century, but it was not until the work of Bordes and Tixier that their true technological status, related to the microburin technique, was universally accepted (see Brézillon, 1968:137; Bordes, 1957; Tixier, 1963; Dinizan et al., 1992:69). It then also became common knowledge that the microburin technique, “although it permitted the manufacture of various types of tools is primarily associated with the manufacture of geometrical microliths…” (Dinizan et al., 1992:69). Microburins themselves were never desired products, but rather waste products from the production of other objects.

Among the pieces exhibiting the typical oblique microburin scar, a peculiar kind was distinguished and named “Krukowski” microburin. Tixier describes these pieces as follows (1963:142): “The extremity of a backed blade or bladelet detached by the “microburin” technique, which is applied to the backed edge” (our translation). Most often, these objects are not notched and the microburin was detached at the intersection of the back with the ventral face of the blank.

Along with these basic observations, Bordes also raised the question of the intention of the technique. Through experimentation, he verified that true microburins can appear sporadically as accidents when backing bladelets by “crushing percussion, or anvil percussion” (Bordes, 1957:580-581 – our translation). This occurs more frequently at the distal end of the piece (producing distal microburins), but sometimes at the prox-
nal end as well. From this perspective, Krucowski microburins were interpreted primarily as accidents. This conclusion was slightly amended by Tixier on the basis of large Krucowski microburins, which Capsien toolmakers probably intended to turn backed blades (not bladelets) into scrapers or burins (Tixier, 1963:144).

When Garrod recovered microburins at el-Wad upper B2 and B1, it was the first time the technique was found in clear association with well-identified Levantine industries (Garrod, 1932). Because the objects were then thought to be tools, their significance beyond a possible chronological one was not immediately sensed, though seemingly ignored during the earlier Natufian phase, this "tool" was characteristic of certain later industries of the culture. The technological perspective revealed by the work of Bordes and Tixier revived interest in this topic. Bar-Yosef (1979:166) detected a possible cultural meaning when he observed "that the knowledge of manufacture and the habitual preference for producing microblades with the aid of the microburin technique was held by only certain human groups". Careful counting of sieved samples led to more technological and behavioral interrogations. Krucowski microburins and pieces with *pajant-triedres* were always few, but some assemblages included far more microburins than necessary to prepare the recorded number of microliths. This observation suggested "two possibilities: one, the site was only an atelier; or, two, the geometries were removed for hunting and fishing activities while the debitage was discarded at the site" (Bar-Yosef 1970:129).

During the following years, interest in the microburin technique in the Levant intensified due to the recognition of new archaeological entities, some including microburins and others did not, that emerged from extensive fieldwork. Both regional and chronological patterns were traced. Work in the Negev and northern Sinai demonstrated extensive practice of the microburin technique in this area, irrespective of cultural separations except for the Geometric Kebaran, from the Mushabian through the Harifian. Despite early manifestations of the technique (often associated with triangles), the impressive amount of typical waste products in the Negev prompted the hypothesis of a late importation from Africa (Philips and Mintz, 1977:183). As for the Natufian, systematic reappraisals showed that the situation was much more complex than that postulated by Garrod and Neuville. Microburins were already found in some Early Natufian assemblages. The practice of this technique during the Natufian indicates that the groups using it cohabitated in the region for the entire period with others that did not (Bar-Yosef and Valla, 1979).

In this context, and seriously considering Tixier's (1963:145) recommendation emphasizing the possibility that Krucowski microburins could be extremely small, Valla found that some Natufian industries he considered to be Late or Final (Hayonim Terrace upper layer, Eynan 1b) had large quantities of those waste products. The pieces were usually no more than a few millimeters long. Many of them had removed either a truncation or a convex back. Though the retouched edge was sometimes concave and very short, it was not possible to interpret it as a purposefully made notch. All in all, they seemed to be the products of butting, exhibiting retouch on one edge and the typical microburin scar developing from that edge on the ventral face. Were these objects a case for the intentional use of the "Krucowski microburin technique"? Valla raised this possibility, but as usual when dealing with purely technological matters, he did not want to be too affirmative. "Experimentally, miniscule Krucowski microburins, comparable to those of Hayonim or Mallaha, are easily obtained when trying to reproduce small luunates, though it is feasible that the Natufians purposefully reduced the length of their luunates, it remains hypothetical that they did it through deliberate use of the "Krucowski microburin technique" (1984:180 – our translation).

**PRESENT STATE OF KNOWLEDGE**

Researchers prefer to subdivide the Natufian Culture in different ways (some adhere to a two-fold division whereas others refer to three stages), but general trends concerning flint retouching are now commonly accepted. The result is a complicated picture, elaborating on the foundation of ideas already established by D. Garrod and R. Neuville. It is accepted that the Heiwan bifacial retouch, very common on luunates at the beginning
of the culture, tends to disappear from these microliths through time. It is also accepted that a concomitant trend toward increasingly smaller lunates can be observed through time. Another trend can be traced in the use of the microburin technique, with waste products tending to be increasingly frequent in later assemblages (Valia, 1995). Meanwhile, these general trends are combined with important variations. Within the limits of the scope of this paper, which deliberately ignores inter-regional differences in debitage methods and products, a wide range of variability exists between assemblages of a broadly similar age. Such differences have been traced both from site to site in the same region and on a larger scale at the level of geographic entities. For example, the decline in the use of Helwan retouch seems to occur progressively in the Carmel-Galilee area as opposed to a much more abrupt change in retouching techniques in the Negev. Similarly, the relative quantity of geometric microliths (mainly lunates), compared to non-geometric ones (mainly retouched and backed bladelets), is by no means uniform in the two areas. Whereas throughout the Natufian period assemblages from Carmel and Galilee have more bladelet tools (most of them with direct retouch) than lunates, the opposite is true in the Negev. This phenomenon should not be overlooked when considering the diversity of retouching techniques used by prehistoric toolmakers.

In terms of size, the alleged tendency toward smaller lunates is observed everywhere, but Early Natufian lunates, for example, are similar neither in average length nor in general outline at nearby sites in the Carmel-Galilee area. Moreover, the lunates from the Negev sites, and possibly from the Middle Euphrates sites, tend to be longer and more elongated than those from the Carmel-Galilee area.

The microburin technique shows its own pattern in which some assemblages exhibit large numbers of diagnostic waste products, while others have virtually none. Again, some sort of contrast can be observed between the Carmel-Galilee area, where moderate numbers of microburins, sometimes of the Krukowski variety, are noted at some sites, and the most southern part of the Levant where quantities of regular microburins always appear. At the northern extremity of the Natufian territory, limited use of the microburin technique, mainly of the Krukowski type, was reported from the Middle Euphrates area (Olszewski, 1986).

Finally, the emerging picture resulting from a relatively superficial approach to Natufian micro lithic assemblages consists of the sum of these contrasts and small differences. It explains the difficulties encountered in subdividing the Natufian Culture into clear-cut stages. We hope that the approach advocated in this paper will contribute to a more comprehensive view of the data than that of the current approach, thus giving meaning to observations that when considered independently are difficult to understand. Ultimately, the integration, into coherent procedures, of observations previously not properly related to each other may help to build a more coherent view of the "technical system" of the culture in its synchronic variability as well as its trends of change.

SAMPLE CHOICE AND LIMITATIONS

In this study, aimed at reconstructing the dynamics of Natufian lunate retouch, we chose to concentrate on two samples collected at Eyunan, rather than attempting to achieve an overview based on the analysis of lunates from different sites. This option could be seen as a shortcoming since it might suggest that these samples are taken as representative of different contemporaneous Natufian groups sharing identical ways of producing similar retouch. We stress, however, that we do not support this hypothesis, which, as described above, is not tenable based on present knowledge. On the contrary, considering the diversity of Natufian technical behavior, we chose to initially concentrate on restricted and homogeneous samples in order to simplify the matter as much as possible. We consider our work to be an exploratory study with a primarily methodological orientation. Being restricted to lunates, it is not intended as a systematic analysis of the range of retouching techniques used by any specific group at a given time, nor for the purpose of identifying any supposedly exclusive methods for the fabrication of this type of micro lith in the Natufian context. Our objective is rather to test a method for reconstructing the reasons behind changing retouch characteristics through time at a single site.
on microliths broadly similar at least in terms of shape. We stress that a general revision of Natufian tool assemblages, as useful as this would be, is not the aim of this paper. Due to our interest in the diachronic aspect of lunate manufacture, we believe Eynan to be a good case study because it offers both Early and Final Natufian industries in relatively undisturbed levels. Moreover, selecting samples from a single site eliminates the important factor of raw material variation. We are perfectly aware that the analysis presented here concerns the retouch of lunates at Eynan and that our observations should not be extended to other sites without further examination.

Considering our focus on changing habits through time, one could ask why we did not analyze Late Natufian microliths. This is because the sample availability and quality did not permit this option. The Early Natufian material we chose to study was collected from the floor area of house 131 (Valla, 1988), where the conditions in terms of stratigraphic position and recovery techniques are excellent. Our Final Natufian sample is not as optimal since it was collected from fill outside the buildings. Nonetheless, it was selected from a certain Final Natufian deposit isolated from earlier levels and carefully sieved. Similar samples, large enough for this study, were not readily available from the Late Natufian deposits, most of which were excavated between 1955 and 1961. The lack of observations concerning Late Natufian lunates is thus a clear shortcoming of this study and it underlines the need for further research in the field of changing retouching techniques during the Natufian at Eynan and elsewhere.

ANALYSIS OF THE MICROLITHS (O.M.)

Before describing in detail the Early Natufian and Final Natufian assemblages, some general considerations should be emphasized. These are a direct consequence of our technological approach in general, and of the specific aims of this study in particular. Our main objective is to understand the activity of microlith retouching as a dynamic process that includes different steps such as, blank selection, retouching (i.e., technique and method), hafting and discard. We assume that each stage of this process is characterized by different types of products, all of which are present at the site (e.g., microlith rejects, broken microliths that were replaced on-site, or microliths that were used and subsequently discarded on-site). This dynamic process is well-documented at short, single occupation Epipaleolithic sites (including Natufian) in the western Negev, which were extensively refitted and analyzed (Davidson and Goring-Morris, 2003; Goring-Morris et al., 1998; Marder, 2003). For these methodological reasons, we tried to identify, in both the Early and Final Natufian assemblages, unfinished microliths that were rejected during lunate preparation and microliths with impact damage that were discarded after use.

From this perspective, our hypothesis is that in most of the cases the different modes of lunate retouch (i.e., bifacial oblique, alternating, inverse or even direct non-vertical) in the Early Natufian of Eynan did not result in discrete lunates. Rather, they were most often produced by the same method and technique within a dynamic process of lunate preparation. According to the same logic, we separate another retouch mode, direct vertical, since we hypothesize that it was formed by a different method and technique. We will now specify some descriptive choices used in our study of Early and Final Natufian artifacts. To describe the angle of the retouched edge, we follow the terminology used by Valla (1984:26), following Leroi-Gourhan et al. (1966:252–253) in which “oblique” corresponds to retouch that creates an angle of 40–60°, “abrupt” to an angle between 60–80°, and “vertical” to an angle of around 90° (Fig. 3). In Figure 4, we present the classic metric attributes used to describe microlith dimensions. In addition, following Valla (1984: 28–29) we measured the lunate radius in order to estimate the degree of curvature, a characteristic that shows noticeable contrasts between the Early and Final Natufian assemblages.

EARLY NATUFIAN GEOMETRIC MICROLITHS/LUNATES

The sample

The sample of geometric microliths is rather small, consisting of only 62 lunates and one triangle (N = 63; Figs. 5–6). Five lunate fragments, most less than 12 mm in length, were omitted from the analysis.
Within the lunate group, there are four artifacts that, based on strictly typological grounds, are not typical lunates. They have an irregular, convex back, an occasionally convex working edge and one obliquely truncated end. They were nonetheless included in the analysis. Three were considered as lunate preparation rejects and one, which shows impact damage, was considered as abandoned after use (see below).

The geometric microliths can be divided into two distinct groups according to retouch characteristics. The first group is the Helwan family, sensu lato ($N = 56$), which according to our approach was mostly prepared by the same retouching method. The second group includes seven microliths with vertical retouch. The artifacts in the Helwan sensu lato group have bifacial oblique, alternating, direct or inverse retouch (sensu Mazar et al., 1992). Among them, 35 were modified by bifacial oblique retouch and 12 by alternating retouch. These objects are characterized by retouch that modifies both faces of the lunates. Additionally, there are eight objects with direct retouch and one object with inverse retouch. Within the Helwan group there are six objects (10.7%) considered as microliths abandoned during production. These microliths are distinguished by irregular dimensions (especially width), irregular...
retouch and a convex cutting edge. However, we were very cautious in classifying these artifacts within the “lunates in preparation” sample, since each of the lunates with impact damage also displayed some irregular features (e.g., extreme thickness, irregular scar pattern, non-acute retouched back, etc).

The second main group consists of seven lunates that display direct or crossed vertical retouch (approximately 90°). They are longer (23.67 ± 5.88 mm), thicker (3.00 ± 0.58 mm) and a bit wider (9.00 ± 2.24 mm) than the average Helwan lunates (Table 1). They vary in length from medium (between 15–20 mm) to large (be-
Fig. 6. Lunates from the Early Natufian layer at Eynan. Drawings by L. Zieger (4–8, 11–13) and D. Ladiray (1–3, 9, 10). Note impact damage on 11.

tween 21–33 mm; Fig. 7). When taking into account the ratio radius/length, it is evident that most of them fit well within the size distribution of the Helwan sensu lato group (Fig. 8).

Despite the possible intrusive nature of the lunates with direct retouch (both abrupt and vertical) in the Early Natufian assemblages (e.g., Negev region Goring-Morris, 1987), they were included in this analysis since the technological reconstruction indicated that they can result from the manufacture of a specific group of lunates with vertical retouch (see below “retouching methods”). An additional argument for including these lunates in the sample is that there are other
Table 1

Metric characteristics of Early Natufian lunates

<table>
<thead>
<tr>
<th></th>
<th>Average length (mm)</th>
<th>S.D. C.V.</th>
<th>Average width (mm)</th>
<th>S.D. C.V.</th>
<th>Average thickness (mm)</th>
<th>S.D. C.V.</th>
<th>Average length/width</th>
<th>S.D. C.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helwan s. lato*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 45, 50, 50, 45</td>
<td>22.29</td>
<td>3.92</td>
<td>8.94</td>
<td>1.60</td>
<td>2.36</td>
<td>0.69</td>
<td>2.41</td>
<td>0.36</td>
</tr>
<tr>
<td>minimum</td>
<td>13</td>
<td>0.18</td>
<td>5</td>
<td>0.18</td>
<td>4</td>
<td>0.29</td>
<td>1.75</td>
<td>0.15</td>
</tr>
<tr>
<td>maximum</td>
<td>29</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td>3.86</td>
<td></td>
</tr>
<tr>
<td>Helwan in prep.</td>
<td></td>
<td></td>
<td>11.50</td>
<td>1.22</td>
<td>2.67</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N= 6, 6</td>
<td>-</td>
<td></td>
<td>10</td>
<td>0.11</td>
<td>2</td>
<td>0.31</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>min. max.</td>
<td>-</td>
<td></td>
<td>13</td>
<td></td>
<td>-</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Helwan s. lato on bladelets</td>
<td>22.38</td>
<td>3.80</td>
<td>9.14</td>
<td>1.53</td>
<td>2.46</td>
<td>0.64</td>
<td>2.47</td>
<td>0.28</td>
</tr>
<tr>
<td>N = 26, 28, 28, 26</td>
<td></td>
<td>0.17</td>
<td>6</td>
<td>0.17</td>
<td>2</td>
<td>0.26</td>
<td>2</td>
<td>0.11</td>
</tr>
<tr>
<td>min. max.</td>
<td>15</td>
<td></td>
<td>13</td>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helwan s. lato on flake</td>
<td>19.71</td>
<td>4.11</td>
<td>9.00</td>
<td>1.60</td>
<td>2.56</td>
<td>0.72</td>
<td>2.27</td>
<td>0.29</td>
</tr>
<tr>
<td>N = 7, 9, 9, 7</td>
<td>12</td>
<td>0.21</td>
<td>13</td>
<td>0.24</td>
<td>4</td>
<td>0.28</td>
<td>2</td>
<td>0.13</td>
</tr>
<tr>
<td>min. max.</td>
<td>13</td>
<td></td>
<td>5</td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Bifacial oblique</td>
<td>21.89</td>
<td>2.57</td>
<td>9.10</td>
<td>1.09</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>**N = 39, 39</td>
<td>nd</td>
<td>0.12</td>
<td>nd</td>
<td>0.12</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>mix. max.</td>
<td>nd</td>
<td></td>
<td>nd</td>
<td></td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
</tbody>
</table>

* Helwan sensu lato include bifacial oblique, alternating and inverse retouch
** After Valla 1984

Early Natufian sites where this type of retouch is also an integral part of the assemblage (Byrd, 1991; Edwards, 1991; Valla, 1984).

General description

Of the 56 Helwan lunates, 67.9% are whole while the remaining objects are broken (n = 18). The broken group includes four objects that are broken at the extreme proximal or distal tip and are thus nearly whole. In contrast, the lunates with direct vertical retouch include more whole artifacts (85.7%). This is probably due to the relative thickness of these objects in comparison to Helwan lunates (3.00 ± 0.58 mm versus items 2.36 ± 0.69 mm). Among the Helwan lunates, the frequency of burnt artifacts is 14.29%. Most of the flint nodules (ca. 80%) found at Eynan have origins less than 10 km from the site, while certain other flints come from more distant sources, occasionally more than 20 km away (Delage in Valla et al., 1999; Delage, 2001). The Early Natufian lunates are made from good quality, fine-grained, non-chalcedony, regular flint with a few chalk inclusions on four objects. However, their color is highly diverse, ranging from dark grayish brown to light brownish beige to yellow. Despite the fact that the flint utilized at Eynan is variable in terms of geological age, size and quality, for lunate production we observe a clear preference for good quality, fine-grained flint with a homogenous texture (Delage in Valla et al., 1999; Delage, 2001).

Only two of the lunates have a piquant-trièdre (3.6%). This observation is congruent with a previous analysis of the assemblage, which indicated that this technique was rarely used at Early Natufian Eynan (Valla, 1984).

A detailed metric analysis of the Helwan lunates is presented in Table 1. The standard deviation (S.D.) and coefficient of variation (C.V.)
Fig. 7. Length/radius of Early Natufian lunates with direct retouch

Fig. 8. Length/radius of Early Natufian lunates with Belwan *sensu lato* or inverse retouch
(mean divided by standard deviation and converted into percentages) are homogenous, suggesting that despite the small size of the sample (< 100), it is statistically valid. The current lunate sample is similar in length and width, though it is slightly shorter and wider in comparison to past samples (Valla, 1984). Determination of the blank type selected for lunate production proved to be difficult. The lunates often possess irregular features, such as scar pattern, a cutting edge that is not parallel to the arissee, convex profile, etc. Moreover, retouch reduces the width of the blank, occasionally reaching the central arissee, making identification of the blank difficult or sometimes impossible.

Within the Helwan group, 53.6% of the lunates were made on bladelets, 21.4% on flakes, and 25% on indeterminate blanks. Most of the Helwan lunates made on bladelet blanks have a uni-directional straight or uni-directional convergent scar pattern (71.4%), while the remaining objects have a multi-directional, mainly simple opposed scar pattern. These artifacts display one (40%) or two arisseees (46.8%) with usually straight (80%) and parallel cutting edges (67%). In contrast, some Helwan lunates are less regular in form and dimension, indicating that they were made from flake blanks. These usually have a multi-directional, simple opposed, irregular or radial scar pattern (60%) with a variable number of arisseees (0–4). Straight cutting edges are uncommon (35.5%) and this edge is not parallel to the arisseees. Additionally, these artifacts are shorter and a bit wider compared to those made on bladelets (Table 1). At this stage of analysis, we should ask whether the difference observed between the overall regularity of bladelet versus flake blanks is also manifest on the retouch characteristics of Helwan lunates.

It seems that the irregularity observed in blank selection is related to the fact that some of the most irregular blanks are actually objects that were abandoned during microlith production. We distinguished “lunates in preparation” by their irregular retouch (60%), diffuse and non-uniform retouched edge scar pattern and relatively wide scars (4–6 mm: for definition of these criteria see below “Retouch Regularity”). Among the lunates in preparation, three are made from flakes, two from bladelets and one from an indeterminate blank. Most are broken (four of six objects). They are distinctively wider (11.50 ± 1.22 mm) and a bit thicker (2.67 ± 0.81 mm) than other Helwan lunates (Table 1).

At this stage of our study it is important to ask why those items were abandoned. The fact that most of the “lunates in preparation” (five out of six) displayed three, or even more, retouch series (see below “Retouching methods”) indicates that the majority was discarded after intensive transformation of the retouched edge. During this transformation, several of those artifacts were broken (three), sometimes at a weak point of the blank (i.e., chalk inclusion; Fig. 6:8), and discarded. In other cases, the objects were abandoned because of their overall irregular shape and dimension, meaning they were too robust, amorphous or displayed uneven back thickness (Fig. 6:6–7).

Retouch regularity

One of the aims of this study was to establish criteria to define, in the specific context of Eynan, the commonly used terms “regular” or “irregular” retouch, which are usually based on empirical estimations (e.g., Inizan et al., 1992: Fig. 35:14–15). In our preliminary empirical observations, we first conducted a qualitative observation followed by a quantitative analysis. To demonstrate the rate of retouch regularity, two complementary indices were used: retouch density (RDI) and retouch uniformity (RUI). We must emphasize that both of these “indices” are only approximate since it was very difficult to precisely count the number of scars on each retouched edge, or to precisely measure each minute scar. Moreover, it is necessary to point out that if a retouched back displays high degree of uniformity, it usually exhibits a dense scar pattern as well, though counter examples were also recorded.

The retouch density index was calculated by the following ratio: RDI = number of scars/retouched edge length (Fig. 9). According to this index, a higher ratio indicates a denser scar pattern on the retouched back of the microlith. In cases where two successive series of removals were observed on the same edge at the same location, the last series of removals was better preserved and therefore systematically recorded. The retouch
Retouch Density Index = \( \frac{\text{Number of scars}}{\text{Retouched edge length}} \)

\[ RDI = 0.52 \text{ scar/mm} \]

\[ RDI = 0.59 \text{ scar/mm} \]

**Fig. 9. Retouch Density Index**

uniformity index was calculated by the following difference: RUI = wider scar width – scar average width (in mm; Fig. 10). According to this index, a higher value indicates a less uniform scar pattern on the retouched back of the microlith.

In general, the Helwan lunates at Eynan were modified by non-stereotyped retouch. This lack of stereotype is shown by the fact that the bifacial oblique retouch rarely extends along the entire object (in only six cases – 17.1%). Bifacial oblique retouch commonly appears only on a section of the edge (82.9%), while other parts were modified by direct-abrupt and inverse retouch. In a few cases, some sections were not modified at all. In addition, this lack of stereotype is also visible in the relative abundance of Helwan lunates with irregular retouch. Finally, it also appears on lunates that were fabricated by alternating retouch.

A significant number (29.5%) of the lunates were produced by irregular retouch. However the majority (70.5%) of the Helwan lunates display regular to very regular bifacial oblique, alternating or inverse retouch (Table 2). The regularly retouched Helwan lunates are characterized by a uniform and dense scar pattern on the back (uniformity value: 0.89 ± 0.14 scar/mm) and a relatively narrow largest scar (average: 2.20 ± 1.18 mm). In contrast, the irregularly retouched Helwan lunates are characterized by a less uniform and less dense scar pattern on the back (uniformity value: 1.39 ± 1.28 mm;
Retouch Uniformity Index =
Wider scar width – scars average width *

*Scars average width = \( \frac{\text{Retouched edge length}}{\text{Number of scars}} \)

RUI = 3.4 mm  
RUI = 0.7 mm

Higher uniformity

Fig. 10. Retouch Uniformity Index

Early Natufian lunates: retouch regularity frequency in the Helwan group

<table>
<thead>
<tr>
<th></th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whole assemblage**</td>
<td>Items on bladelets</td>
<td>Items on flakes</td>
</tr>
<tr>
<td></td>
<td>dorsal &amp; ventral faces</td>
<td>dorsal &amp; ventral faces</td>
<td>dorsal &amp; ventral faces</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Regular</td>
<td>67</td>
<td>70.5</td>
<td>42</td>
</tr>
<tr>
<td>Irregular</td>
<td>28</td>
<td>29.5</td>
<td>11</td>
</tr>
<tr>
<td>Total *</td>
<td>95</td>
<td>100.0</td>
<td>53</td>
</tr>
</tbody>
</table>

*When the regularity attribute was "indeterminate", items were excluded from the analysis
**Including items the original blank of which could not be determined
Early Natufian lunates: retouch regularity frequency in the Helwan group.

Comparison between dorsal and ventral faces

<table>
<thead>
<tr>
<th></th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whole assemblage**</td>
<td>Whole assemblage**</td>
<td>Items on bladelets</td>
<td>Items on bladelets</td>
<td>Items on flakes</td>
<td>Items on flakes</td>
</tr>
<tr>
<td></td>
<td>dorsal face</td>
<td>ventral face</td>
<td>dorsal face</td>
<td>ventral face</td>
<td>dorsal face</td>
<td>ventral face</td>
</tr>
<tr>
<td>Regular</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>35</td>
<td>66.0</td>
<td>32</td>
<td>76.2</td>
<td>20</td>
<td>69.0</td>
<td>22</td>
</tr>
<tr>
<td>Irregular</td>
<td>18</td>
<td>34.0</td>
<td>10</td>
<td>23.8</td>
<td>9</td>
<td>31.0</td>
</tr>
<tr>
<td>Total*</td>
<td>53</td>
<td>100.0</td>
<td>42</td>
<td>100.0</td>
<td>29</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*When the regularity attribute was "indeterminate", items were excluded from the analysis

**Including items the original blank of which could not be determined

Early Natufian lunates: retouch regularity indices in the Helwan group

<table>
<thead>
<tr>
<th>Retouch regularity*</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
<th>Helwan lunates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ventral face uniformity</td>
<td>dorsal face uniformity</td>
<td>ventral face density</td>
<td>dorsal face density</td>
<td>ventral face largest scar</td>
<td>dorsal face largest scar</td>
</tr>
<tr>
<td>Ratio</td>
<td>S.D.</td>
<td>Ratio</td>
<td>S.D.</td>
<td>Ratio</td>
<td>S.D.</td>
<td>Ratio</td>
</tr>
<tr>
<td>Regular</td>
<td>0.91</td>
<td>0.71</td>
<td>0.85</td>
<td>0.76</td>
<td>0.60</td>
<td>0.13</td>
</tr>
<tr>
<td>Irregular</td>
<td>1.36</td>
<td>1.16</td>
<td>1.50</td>
<td>1.22</td>
<td>0.38</td>
<td>0.10</td>
</tr>
</tbody>
</table>

*When the regularity attribute was "indeterminate", items were excluded from the analysis

density ratio: 0.44 ± 0.13 scar/mm) and a much wider largest scar (average 3.74 ± 1.65 mm). Within the Helwan lunate group, there is a correlation between retouch uniformity and the type of blank employed. It is obvious that Helwan lunates on bladelet blanks are more regularly retouched than those made on flake blanks (79.2% versus 61.9%; Table 2). These differences indicate that blank standardization affects the degree of retouch regularity. In cases where the selected blanks are bladelets, which have parallel arises, a straight cutting edge and, usually, a rectilinear profile, the retouch is more regular, while in the cases where less uniform flake blanks were chosen, the retouch was more often irregular.

In addition, it also seems that there are differences in the degree of regularity between the dorsal and ventral faces of Helwan lunates. Irregular retouch is more frequent on the dorsal face (34%) than on the ventral face (23.8%). This phenomenon is emphasized when comparing bladelet and flake blanks (8.3% versus 36.4%; Table 2). However, when calculating the different indices of both the ventral and dorsal faces of the Helwan lunates, a more complex picture arises: the retouch of the ventral faces of the Helwan lunates is slightly more uniform than that of the dorsal faces, but they display a slightly more diffuse scar pattern with a wider largest scar (see detailed description Tables 3–4).

We hypothesize that these differences are due to the geometry of the artifact and the retouching method, which we will describe below. As a consequence of artifact geometry, it was much easier to modify the ventral face of the object by retouch. Reconstruction of the method seems to show that the objective of the primary retouch on the dorsal face was to create a "striking platform"
for the succeeding removals from the dorsal face in the direction of the ventral side. Consequently, this first series of short direct retouch created rather irregular edges. Usually, the toolmaker subsequently retouched the ventral face of the lunate in order to achieve curved, acute and regular retouched edges. This was accomplished by relatively deeper and larger removals (3–5 mm), which formed not dense, but uniform edges. Finally, a careful punctual retouch was occasionally completed by removals leaving large scars (3–5 mm), which contributed to the irregularity of some edges.

**Impact damage**

Five artifacts with impact damage and two other objects with similar scars possibly due to the same use were found within the Helwan lunate sensu lato assemblage (Fig. 5:12). One other object with impact damage (Fig. 6:11) was found among the direct, vertically retouched lunates (12.7% of the entire assemblage). All of these objects show a transverse, mainly oblique, burn-like blow (as described and illustrated in Valla, 1987: Fig. 1:1–4; see also Bergman and Newcomer, 1983). However, the fracture on the objects with possible impact damage is much shorter than on the objects within the certain impact damage group.

No clear pattern appears in the selection of blanks used to manufacture these finished tools. Five are made on bladelets, two on indeterminate blanks and one on a flake. Furthermore, other than the presence of impact damage, these objects do not display any distinct characteristics that would separate them from other lunates. Their morphology (general form, number of arrises, cutting edge form), dimensions, retouch type (bifacial oblique or alternating), blank type, and retouch regularity are similar to that of the other lunates in the assemblage. They do not display a higher degree of regularity (38.4% produced by irregular retouch).

We made a tentative reconstruction of lunate hafting according to the position of the burn-like scar. The transverse oblique position of this scar suggests that these particular objects could have been inserted as a tip in a transverse and slightly oblique position (Fig. 11; see also Bar-Yosef, 1987:Fig. 1:3; Clark, 1975–1977:Fig. 1:4) or as oblique barbs (e.g., Bar-Yosef, 1987:Fig. 1:12), but not horizontally at the tip of the shaft or vertically along the edges.

**Retouching methods (B.V.)**

We shall now consider the logic behind the retouch of Early Natufian lunates at Eynan. In other words, we will explain which method the toolmakers chose to shape microliths. Following Tixier, the concept of “method” has been primarily used to describe “operational sequences” (chaînes opératoires) of debitage. However, it can also be useful for describing retouch processes such as the ones we analyze here. Indeed, as J. Pelegrin explains “the term method (...) covers (...) the different organization – placement and ordering of successive removals – determined by the knapper during a well thought out proce-
dure" (1995:23 – our translation). We have found that it is quite easy to reconstruct these sequences in the case of Early Natufian lunates from Eynan. Among the 63 lunates described above, we selected 61 artifacts for this analysis: one heavily burned piece and one small fragment were excluded. Among these 61 microliths, 45 with bifacial (33) or alternating (12) retouch preserved, until their discard, successive traces of more than one “series” of retouch, for which it is possible to analyze the order. “Series” is the term chosen by Cahen (1981) and Pigeot (1983:24) to describe short debitage processes separated from one another by a change in the orientation of the core. In our specific context, series refers to one retouching process conducted from one face, without prejudging its distribution on the edge (total, partial or “local”, i.e., consisting in one or two removals). We thus consider that the Natufian toolmaker produced a new series when he changed from one face to another. The chronology of these successive series is rather easy to analyze on the 45 lunates with bifacial or alternating retouch since the last retouching processes do not totally hide the previous ones, as is the case for three other lunates modified by crossed retouch. In our assemblage, we also found microliths that retain traces of only one retouch series: among the 61 selected, there are 13 with only direct (12) or inverse (one) retouch.

According to our observations, the number of series from one artifact to another is absolutely not standardized (ranging from a minimum of one to a maximum of four – note 1). This diversity represents a first serious problem for analysis. There is general agreement that each assemblage of microliths could include diverse proportions of armatures discarded during manufacture, some that were completed but not used, some that were used and abandoned after re-hafting, and perhaps some that were discarded after re-sharpening. It is thus possible that the diverse number of retouch series visible on our microliths reflect, to a certain extent, the dynamic processes of shaping, using and re-using of armatures. Unfortunately, we have little certitude on this matter. As mentioned above, only seven microliths bear explicit macroscopic use-wear that corresponds to impact damage (five certain and two possible; Fig. 5:12, Fig. 6:11). We can be sure that these damaged microliths were considered as completed armatures by Natufian people, since they were used. There are six other lunates that we considered, for different reasons, to have been discarded during fabrication (Fig. 6:5–8). In contrast, the reasons for the discard of the 48 other lunates, and therefore their state of completion, remain unknown. On one hand, these microliths could have been used without registering any diagnostic damage, as is often the case with experimental projectile armatures (e.g., Christensen and Valentín, 2004). They could also have been abandoned before use if they were considered to be ineffective. However, none is sufficiently atypical to be definitely considered as ineffective for use. To summarize, only seven artifacts in our sample can be identified as broken by impact and certainly completed before discard, and six others as discarded before completion. We will see below that this lack of information concerning the state of completion of most of the artifacts sometimes limited our capacity to identify retouching methods.

**Observations concerning lunates with oblique, bifacial and alternating retouch**

We will first consider the lunates with at least two series of retouch and whose chronology can be reconstructed: this is the sample of 45 artifacts that bear oblique bifacial or alternating retouch. To reconstruct the retouching method, we observed the number of series, their position sensu Tixier (direct or inverse) and their distribution along the modified edge (total, partial or local). To analyze the distribution, we divided the length of microliths into six equal portions, designated as “a-b-c-b-a” (Fig. 12). We did not take into consideration whether the retouch was proximal or distal because this is often difficult to determine on very small parts of the original blank. The “a” portions therefore concern the two ends, the “c” portions designate the mesial part, and the “b” portions correspond to the areas between the mesial part and the ends. The distribution of the retouch was considered as “total” when the whole edge was transformed (i.e., covering a-b-c-b-a, that is 6/6 of the length). The distribution was considered “partial” when it continuously covered between 3/6 and 5/6 of the length. The distribution was considered “local” when it concerned
between 1/6 and 2/6 of the length. These are the main attributes that we took into consideration for a very precise reconstruction of the retouching method. We will now give a detailed outline of this reconstruction to ensure that our methodology can be repeated. We will close each step of our reasoning with a synthetic report.

Number of series and position of retouch

For 25 lunates (15 with bifacial retouch and 10 with alternating retouch), we can infer that the earliest visible series definitely corresponds to the initial one (i.e., the very first one) and, therefore, that the number of observed series is equal to the number of series effectively carried out (Fig. 13:1–5, Fig. 14:1–2).

Among these 25 lunates, a large majority (68%) reveals only two series (Table 5). The initial series has a direct position on 20 microliths (80%). Among these, four were certainly completed and used because they are broken by impacts. Only five lunates reveal an initial series with an inverse position. This pronounced difference concerning the retouch position reflects a clear choice, which we will discuss below in the chapter concerning retouching techniques.

![Fig. 12. Division of the retouched edge in six portions for analysis of retouch distribution](image)

For the other 20 lunates with bifacial or alternating retouch, it is not certain that the earliest visible series corresponds to the initial one. This is because the degree of edge modification during the observed series was so significant that a previous series could have been hidden (Fig. 14:3–4). Among these 20 lunates, 10 reveal at least two series (i.e., exactly two or possibly three if the initial series was hidden by further ones), eight reveal a

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Early Natufian: 25 lunates on which the earliest visible series certainly corresponds to the initial one. Number of series that could be observed. Numbers in brackets correspond to microliths on which the initial series has a direct position.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Two series</td>
</tr>
<tr>
<td></td>
<td>Number of items</td>
</tr>
<tr>
<td>Bifacial</td>
<td>9(7)</td>
</tr>
<tr>
<td>Alternating</td>
<td>8(7)</td>
</tr>
<tr>
<td>Total</td>
<td>17(14)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 6</th>
<th>Early Natufian: 20 lunates on which it is not sure that the earliest visible series corresponds to the initial one. Number of series that could be observed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At least 2 series</td>
</tr>
<tr>
<td></td>
<td>Number of items</td>
</tr>
<tr>
<td>Bifacial</td>
<td>8</td>
</tr>
<tr>
<td>Alternating</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
</tr>
</tbody>
</table>
Fig. 13. Reconstitution of retouching process on Early Natufian lunates on which the earliest visible series certainly corresponds to the initial one.
Reconstructing microlith shaping

Fig. 14. Reconstruction of retouching process on Early Natufian lunates. 1, 2 are microliths on which the earliest visible series certainly corresponds to the initial one; 3, 4 are microliths on which it is unclear if the earliest visible series corresponds to the initial one.
minimum of three series and two reveal a minimum of four series (Table 6). On the majority of these 20 lunates, the earliest visible series displays inverse retouch, but this situation is not forcibly related to that of the initial series since this stage of treatment remains unidentified on these microliths (Fig. 14:3–4).

To summarize, 17 out of 45 lunates (35%) display only two series of retouch. Among these, the proportions of bladelet and flake blanks are equal, showing that there is no clear correlation between this short degree of modification and the type of blank selected. Consequently, the more irregular retouch observed on flakes is related to factors other than the intensity of transformation; it is probably due to some geometric aspect of the blank itself (i.e., irregular scar pattern on dorsal face or irregular thickness). Eighteen other lunates, among which bladelets are as frequent as flakes, definitely display more than two series. The last 10 items exhibit at least two series, but it remains unclear whether it is two series or possibly three that were carried out, since it is not certain that the earliest visible series corresponds to the initial one. In brief, a significant proportion of microliths (35% minimum and maybe more) were manufactured in a way that implied changing the face only once. On these lunates, we remark that, at least on one face, the retouch was distributed on a large portion of the edge.

**Distribution of retouch on each face during successive series**

We closely examined the distribution of retouch series on only 30 complete artifacts among the 45 lunates available (Appendix 1–2; Fig. 13:1–5, Fig. 14:1–2). On 13 of these 30 lunates, the distribution could be analyzed for each series. On the 17 others, it was only possible to analyze the exact distribution for the last series, but this distribution remains indeterminate for the first series visible: it is apparently partial but it is not sure that this corresponds to the original situation since some initial scars could have been suppressed during succeeding, more invasive series.

We note that this ambiguous situation is observed on every complete lunate with alternating retouch, yet the fact that it is impossible to reconstruct the exact distribution of retouch during the first stage of modification raised the question of whether “alternating” is in each case the relevant definition for this kind of retouch. In fact, we cannot exclude the hypothesis that on some of these lunates with “alternating” retouch the initial series was total, rather than partial, but that this total modification could have been locally hidden by succeeding retouch (see e.g., Fig. 14:1). Accordingly, the retouch could have initially been bifacial, before the scars on one face were partially hidden by later, rather invasive removals struck from the other face. Certain aspects of the method already mentioned actually show that most of the “alternating” lunates were transformed in a way similar to the bifacial ones (e.g., the choice to begin with direct retouch). For these reasons, from the beginning of our analysis, we considered that alternating retouch could be most frequently interpreted, in such a Natufian context, as simplified variant of Helwan *sensu stricto* retouch (note 2).

Returning to retouch distribution, among the 30 complete lunates, we will consider separately 17 microliths on which the earliest visible series certainly corresponds to the initial one (Appendix 1) and 13 items on which it is not sure that the earliest visible series corresponds to the initial one (Appendix 2).

Among the 17 lunates on which the earliest visible series certainly corresponds to the initial one, those on which this initial series is totally preserved are very rare (six out of 17; 5 among these six artifacts exhibiting only two series; Appendix 1). In these cases, this initial series consists of a complete treatment of the edge (Fig. 5:3, 9, Fig. 6:6, Fig. 13:1, 5) or a partial treatment on a large portion of the edge (Fig. 5:4, 7, Fig. 13:2–3). On the two microliths with partial treatments, it is worth noting that the retouch stops in the mesial part in an area where the blank presents an original angulation similar to the one that could be created by an oblique retouch.

The second series was carefully observed for each of the 17 lunates: in three cases, the edge was totally modified (Fig. 5:4, Fig. 13:3); in six other cases the treatment is only partial but over a notable length (Fig. 5:3, 5, 7, 10, Fig. 13:1–2, 4, Fig. 14:1). In the eight remaining cases, modification is only local and even sometimes very restricted (Fig. 5:13, Fig. 14:2).
Only four out of our 17 lunates display a third series (Fig. 5:5, 8, Fig. 6:6, Fig. 13:4–5) and one even a fourth series. At this stage, the retouch is always local, except in one case (a lunate with few transformations during the two first series was modified during a third on 3/6 of its edge: Fig. 5:8). This exceptional case corresponds to an artifact on which the treated side exhibits a deep transversal scar created during the debitage phase and preserved during a very gradual retouching process.

We will now examine the 13 additional lunates on which it is not certain that the earliest visible series corresponds to the initial one (Appendix 2). This earliest visible series is totally preserved on seven lunates: during this series, the edge was entirely modified (Fig. 5:2, Fig. 14:3), or partially modified but over a notable length (Fig. 5:6, Fig. 14:4). On one of these two partially treated lunates, the retouched side exhibits a deep axial scar created during debitage: as a result, the natural morphology of this side was partially analogous to the one that could be created through oblique retouch. On 12 lunates, it is possible to analyze the retouch distribution during the second visible series: the distribution is total in five cases, partial over a notable length (> 3/6) in five other cases (Fig. 5:2, 6, Fig. 14:3–4) and only local in the last two cases (Fig. 5:11). Eight lunates among the 13 bear a third series (Fig. 5:6, 11, Fig. 14:4) and possibly a fourth one (Fig. 5:1). At this stage, the retouch is local (Fig. 5:6, 11, Fig. 14:4), except in two cases corresponding to blanks that were slightly thicker than the average (Fig. 5:1).

Preliminary results concerning the retouching method on lunates with oblique, bifacial and alternating retouch

It is now possible to summarize the general rules of the main method, without forgetting that another method could be exemplified by a few lunates modified by alternating and less oblique retouch (see note 2). Most of the lunates with oblique retouch show a minimum of two to four series. During the first two series, the edge intended to become convex was totally retouched in most of the cases, and the transformation generally began by direct retouch. Natufian toolmakers sometimes took advantage of a specific blank morphology (i.e., a favorable angulation on one side) in order to restrict the retouching process. At the end of these two first series — and perhaps already at the end of the initial one — the retouched edge exhibits a rather regular curvature. On a number of lunates — at least 17 out of 45 (note 3) — the retouching process stopped after the two first series were completed (Table 5): this was the case for four microliths among the seven with impact damage. Other lunates — at most 28 (note 4) — were transformed by two or more additional series (Table 5–6). Those microliths with more than two series were in most cases only locally retouched (see discussion below). We must also remember that the number of series and the presence of local retouch seem to be independent of the choice of bladelets or flakes as blanks.

In brief, since often only two series are involved, this method is very simple and probably rapidly performed. The resulting typological aspects are therefore varied: alternating retouch, perhaps only outwardly, rarely total bifacial retouch that is usually partial, i.e., with the addition of simple direct or inverse retouch. Also note that bifacial retouch, when partial, sometimes extends on only a very small portion of the edge, covering 2/6 and even less on four microliths.

How to consider the other Early Natufian lunates with direct or inverse retouch?

In our sample, we are left with 16 lunates with different types of retouch, direct (12) or inverse (one) or crossed (three). Due to observations concerning retouching techniques (see below), we must immediately divide this group of 16 microliths into subgroups. Seven objects, with crossed or direct retouch, are very distinctive in terms of the thickness and the verticality of their retouched edge: these factors restrict the possibility of including them in the same manufacture process as the 45 lunates with oblique retouch. In contrast, nine other lunates display direct or inverse retouch that is notably less abrupt and their mode of manufacture is more compatible with the 45 already described.
Seven lunates with vertical retouch, manufactured by other methods

Among the seven lunates with a vertical and thick edge, three were modified by crossed retouch (Fig. 6:9, 11) and four by a direct retouch that cuts deeply into the width of the blank (Fig. 6:10, 12–13). According to experimental results, this combination of thickness and verticality is very difficult to obtain without the use of some kind of support (see “Retouching Techniques”). The use of such a device is confirmed on these seven artifacts by the character of their retouch, which corresponds most closely to stone percussion. From this point of view as well, these seven lunates are very distinct from most of the 45 others with bifacial or alternating retouch. However, one lunate resembles these in showing a local transformation by inverse retouch: a perfectly vertical crossed retouch is intersected in the medial part of the object by a true “thinning” obtained by flat retouch (Fig. 6:11). This lunate, with an impact trace, therefore displays bifacial sensu stricto retouch. However, it is not true HIlwan retouch because it is not at all oblique. In addition, this thinning produced on a very open angle required the use of a stone “retoucher” instead of pressure (see “Retouching Techniques”). The use of stone is also confirmed by the irregularity of this flat retouch.

In sum, these seven lunates with vertical retouch were clearly manufactured by a process different from the one we have described. The hypothesis of possible intrusions from the upper levels in the stratigraphy of Eyman cannot be excluded. Actually, such intrusions probably also affect the Final Natufian of the same site, in the opposite direction (see below Fig. 21:1–3). Among these seven microliths in the Early Natufian, six are complete and can be metrically compared with the other lunates from the same sample in order to check this intrusion hypothesis (Fig. 7). Actually, only one lunate with a vertical edge is clearly isolated by its very small dimensions (Fig. 6:13), which are more characteristic of the upper levels. It is therefore the only one for which the hypothesis of intrusion could be supported.

For the others, it is not possible to reject or to confirm the hypothesis of admixture and we must keep in mind the discrete presence of a method that is different from the main one which is common to the lunates with very oblique retouch. This other method could correspond to the one we hypothesized to explain the low obliquity of scars on a few lunates transformed by alternating retouch (see note 2 above). Does this correspondence demonstrate the coexistence of two methods in the Early Natufian rather than admixture? This hypothesis cannot be rejected if we take into account the fact that non-geometric microliths, which comprise the majority of armatures in the assemblage, usually display thick and abrupt retouched edges (Valla, 1984:45–46). These non-geometric microliths will have to be carefully analyzed in order to choose between the two solutions, i.e., intrusions or true coexistence of distinct methods.

Nine other lunates that probably correspond to the method used for lunates with oblique retouch

The nine other artifacts with simple direct or inverse retouch bear a more marginal modification, which is abrupt but never vertical. Considering what we learned about the main method, their differences from bifacial or alternating lunates could be very slight. One of these microliths with inverse treatment actually displays a retouch that cuts slightly into the width of the blank (Fig. 6:4). Consequently, it is possible, but not certain, that this retouch removed scars on the other face that belonged to a previous series: this microlith exhibits only one series but this is perhaps an illusion. On the other eight lunates, all with direct retouch, the transformation is more marginal: we can thus assume that these artifacts were treated by only one series (Fig. 6:1–3). From this point of view, they are certainly different from alternating or bifacial lunates, though we noted previously that among the latter, transformations following the first series could sometimes be very restricted (Fig. 5:9, Fig. 14:2).

We are therefore tempted to consider that these nine, mostly direct, lunates are in continuity with the ones with alternating or bifacial retouch. We remind moreover the reader that when the initial series is visible on the latter, its position is direct 80% of the time.

An additional argument related to the curva-
Early Natufian: 9 lunates with direct or inverse retouch. Delineation of the retouched edge. We distinguish the 8 lunates modified by only one series and the one on which a previous series could be hidden by the only one visible.

<table>
<thead>
<tr>
<th></th>
<th>Direct and inverse retouch 1 series and no more</th>
<th>Inverse retouch 1 series minimum</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Number of items</td>
<td>Number of items</td>
</tr>
<tr>
<td>Symmetrical arch</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Non-symmetrical arch</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1 shoulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 shoulders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

Early Natufian: 17 complete lunates on which the earliest visible series certainly corresponds to the initial one. Delineation of the retouched edge.

<table>
<thead>
<tr>
<th></th>
<th>2 series Number of items</th>
<th>3 series Number of items</th>
<th>4 series Number of items</th>
<th>Total Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symmetrical arch</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Non-sym. arch</td>
<td>5</td>
<td></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>1 shoulder</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2 shoulders</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>3</td>
<td>2</td>
<td>17</td>
</tr>
</tbody>
</table>

Early Natufian: 13 complete lunates on which it is not sure that the earliest visible series corresponds to the initial one. Delineation of the retouched edge.

<table>
<thead>
<tr>
<th></th>
<th>2 series minimum Number of items</th>
<th>3 series minimum Number of items</th>
<th>4 series minimum Number of items</th>
<th>Total Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symmetrical arch</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Non-sym. arch</td>
<td>2</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1 shoulder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 shoulders</td>
<td>1</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>13</td>
</tr>
</tbody>
</table>

ture of the retouched edge could be involved in consideration of this continuity. We noted that this curvature was rather regular on alternating and bifacial lunates, even on the ones treated by two series. The nature of this curvature is usually perfectly symmetrical (19 out of 30 complete lunates), meaning that the maximum width corresponds exactly to the mesial one (Fig. 5:3–8, 11, Fig. 6:3–4). It can be also slightly non-symmetrical, meaning that the two widths do not exactly correspond (Fig. 5:2, 9, 10, Fig. 6:2). In other cases, the retouched edge is not perfectly curved.
and displays one or two discrete shoulders (Fig. 5:1, 13-14, Fig. 6:1). Analysis of simple direct or inverse lunates shows curvatures that are more often slightly irregular, especially for the ones that were certainly treated by only one series (Table 7). If we re-examine alternating or bifacial lunates, we note that those treated with few series are also the ones that more frequently display irregular curvatures (Tables 8-9). These observations could therefore support the hypothesis that lunates with simple direct or inverse retouch are microliths on which manufacture was stopped. Does this mean that they were prematurely discarded and considered as unsatisfactory by Natufian people? This is possible for some of them, but this hypothesis must be rejected for at least one lunate with impact damage.

A final remark concerns these lunates with simple direct or inverse retouch: one of them displays a *pequant-triédre* modified by retouch (Fig. 6:2). Is this a characteristic that resembles Final Natufian microliths (see below)? This is in fact not the case because neither its dimension nor the verticality of the edge supports this connection. We must also note that among alternating lunates, another one exhibits a *pequant-triédre* (Fig. 5:14). It is interesting that this type of modification appears only on these two lunates, which were both only slightly transformed by retouch. In other words, the apparent overall scarcity of *pequant-triédre* could result from transformations during successive series on alternating and bifacial lunates, meaning that initial *pequant-triédres* could have been removed on microliths modified by successive series. Moreover, Valla (1984:47) described 16 regular microburns in the assemblage and we will see below that intentional use of this technique could be very efficient in some cases for removing the thicker, proximal part of the blank.

**Concluding remarks: the principal Early Natufian method and its goals**

The question of the delineation of the retouched edge helped us to define the first intention of retouching, which was to create a regular curvature in most cases, i.e., symmetrical 54% of the time (19 out of 30 with bifacial or alternating retouch and three out of nine with inverse or direct retouch). For this aspect, a rather high regularity was therefore desired, and this could be one of the reasons why different series were applied to some microliths. However this regularity does not seem absolutely necessary since one lunate with a shouldered edge shows use traces. In addition, the retouch creates one tip at each end at the intersections between the retouched edge and the cutting edge. However, these two tips are only slightly acute (angles between the retouched edge and the other are between 50° and 70°). Sometimes, one of the ends is not really sharpened and sometimes neither extremity is sharpened. Ends were moreover rarely underlined by retouch of the non-convex edge (for instance Fig. 5:9). It is not certain that these underlinings were performed in order to sharpen the end. They could rather be a consequence of a global rectification of the cutting edge. Two other cases of edge rectification actually exist and they are independent of the ends (Fig. 5:2). This could indicate that specific attention was paid to the straightness of the non-convex edge. In fact, a very high proportion of perfectly straight natural edges emphasize this care. In summary, the desired shape was formed by a convex edge opposed to a rectilinear one, crossing at the two ends without creating acute tips. This shape was sometimes realized after only one series of retouch. So why produce other series of retouch and why change the faces in such cases? This question is equivalent to the question of why direct and inverse retouch are frequently associated.

In our case, we can immediately exclude the hypothesis that the inverse retouch was meant to straighten the profiles of curved edges, as is demonstrated for many types of bifacial productions. In fact, blanks selected for lunates are usually rectilinear in profile and rarely required any rectification by inverse retouch (Table 10). In addition, retouched edges are frequently sinuous (Table 11), which is logical since in many cases different positions of retouch succeed each other on the same edge. This is the case, for example, with alternating retouch and with partial bifacial retouch.

Another possible result of inverse retouch could be a thinning of the retouched edge. However, for most of the microliths studied here, we cannot refer to “thinning” in the strict sense since this inverse retouch was combined with direct re-
touch, while these successive series cut into the width of the blank up to thicker part. The retouched edges are always less acute than the original natural edges, but they nonetheless remain much more acute (between 55 and 75°) than they would have been if they were treated by simple direct retouch (Fig. 15). This is especially true since we may presume that direct retouch could have easily reached a vertical state considering the intensity of transformation of some blanks (more than 12% of the pieces do no longer display arrises on their dorsal face). This intense transformation of some blanks is also related to the impressive consistency in the widths of the end products. This observation allows us to characterize these pieces as "standardized": for all lunates with Helwan and alternating retouch, the coefficient of variation for width is only 18% (Table 1) and it reaches just 8% for the seven lunates with oblique retouch, which were certainly used. This is also true for length, which for all the artifacts with oblique retouch varies only in a proportion of 18%. Yet, we can presume the widths and lengths of the original blanks were much more

<table>
<thead>
<tr>
<th>Table 10</th>
<th>Table 11</th>
</tr>
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<tbody>
<tr>
<td>Early Natufian: 30 complete lunates with bifacial or alternating retouch. Original profile of the blank</td>
<td>Early Natufian: 30 complete lunates with bifacial or alternating retouch. Profile of the retouched edge</td>
</tr>
<tr>
<td>Rectilinear</td>
<td>Rectilinear</td>
</tr>
<tr>
<td>Arched</td>
<td>Arched</td>
</tr>
<tr>
<td>Twisted</td>
<td>Sinuous</td>
</tr>
<tr>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>19</td>
<td>11</td>
</tr>
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<td>2</td>
</tr>
<tr>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

Fig. 15. Angulation of retouched edges: A – retouched edge obtained by Helwan retouch; B – for an equivalent final width direct retouch produces a definitely more abrupt angle.
Table 12

Early Natufian: 30 complete lunates with bifacial or alternating retouch. Distribution of inverse and bifacial retouch

<table>
<thead>
<tr>
<th></th>
<th>Extremities</th>
<th>Between extremities and the mesial part</th>
<th>Mesial part</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Portions “a” (cf. Fig. 12)</td>
<td>Portions “b” (cf. Fig. 12)</td>
<td>Portions “c” (cf. Fig. 12)</td>
</tr>
<tr>
<td></td>
<td>No. of items</td>
<td>No. of items</td>
<td>No. of items</td>
</tr>
<tr>
<td>Inverse retouch</td>
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<td>16</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Bifacial retouch</td>
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<td>12</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Table 13

Early Natufian: 30 complete lunates with bifacial or alternating retouch. Distribution of local retouch

<table>
<thead>
<tr>
<th></th>
<th>Extremities</th>
<th>Between extremities and the mesial part</th>
<th>Mesial part</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Portions “a” (cf. Fig. 12)</td>
<td>Portions “b” (cf. Fig. 12)</td>
<td>Portions “c” (cf. Fig. 12)</td>
</tr>
<tr>
<td></td>
<td>No. of items</td>
<td>No. of items</td>
<td>No. of items</td>
</tr>
<tr>
<td>Items with local retouches</td>
<td>6</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Variable if we take into account that both bladelets and flakes were selected. Therefore, we conclude with the hypothesis that a combination of inverse and direct retouch can be used to obtain constant widths and lengths, as well as a rather regular delineation, without diminishing the acuteness of the retouched edge.

Moreover, it seems that the care related to acuteness is especially pronounced on some specific portions along the retouched edge. As already mentioned by Valla (1984:47), the bifacial treatment, and more generally inverse retouch (taking into account alternating lunates) less often concerns the mesial portion of lunates than it does the other areas (i.e., the areas between the extremities and the mesial part and the ends (Table 12). This is rather logical since the original width is less modified in the mesial area and since the sharpness of the edge is easier to preserve here. When localized retouch occurs, it is incidentally more frequent in these portions between the ends and the mesial part (Table 13). These precise modifications correspond to the specific attention paid by toolmakers, confirming that they specifically intended to preserve a rather sharp edge wherever it was retouched. In our view, the retouching method used by Early Natufian toolmakers therefore corresponds to an efficient compromise between the requirements for morphological standardization on the one hand, and an evident desire to maintain thin, acute retouched edges on the other. The attention paid to thinness could be simply related to the fact that the mode of pressure involved (see “Retouching tech-
Retouch characteristics: 1 - an Early Natufian lunate (drawn Fig. 5:7) showing a typical characteristic of Helwan retouch with short and rather regular removals; 2 - for comparison, an experimental lunate retouched by pressure with a bone tool. Photos by I. Klaric and J. Pelegrin

Fig. 16. Retouch characteristics: 1 - an Early Natufian lunate (drawn Fig. 5:7) showing a typical characteristic of Helwan retouch with short and rather regular removals; 2 - for comparison, an experimental lunate retouched by pressure with a bone tool. Photos by I. Klaric and J. Pelegrin

Techniques') is easier on the acute edge. It is also possible that it was related to the specific requirements of hafting techniques: e.g., consistent dimensions of the grooves into which the lunates were inserted. Unfortunately, there is at present no clear archaeological evidence to support this last hypothesis.

The main result of this attempt to reconstruct the order and logic of the retouch processes applied to Early Natufian lunates at Eynan concerns the possible continuity between bifacial and alternating retouch, and even some direct or inverse treatments. The latter could correspond to simplified versions of Helwan sensu stricto retouch. In addition, we must emphasize that the shape of all these microliths was progressively created: the microburin technique was used in only a few cases, perhaps to suppress the thicker parts of the blanks, followed by a very gradual transformation using a unique mode of oblique retouch. This gradual treatment usually begins with a continuous series on each face. Brief changes to another face sometimes appear, but at the end of the process in order to achieve the shape and to maintain the desired acuteness of the retouched edge.

We shall now consider the techniques associated with the methods reconstructed, beginning with the principal one, Helwan retouch.
Fig. 17. Two possible knapping positions for performing Helwan retouch using a short bone pressure point in one hand: A – the lunates can be held between the fingers and the palm of the other hand; B – the lunates can be pressed with a finger against the knee. Drawings by D. Molez

Retouching techniques (J.P.)

Techniques related to Helwan retouch

Oblique Helwan retouch is always short with scars barely exceeding 3–4 mm in length and width. Different features demonstrate that they were produced by a pressure technique (Fig. 16).

First, on most of the Helwan lunates, we observe several adjacent scars of a similar small size (Fig. 5:3–7, Fig. 6:4–5, 7–8). A percussion technique would forcibly produce more irregular removals since a hammer cannot be controlled with such precision at the scale of millimeters.

In some cases, a retouch scar was created in the concavity of the negative bulb of a previous scar. This type of scar can be produced only with the tip of a pressure tool since a hammer will make its first contact with the asperities of the edge (Fig. 6:5; see the last inverse removal produced inside the notch of the back edge).

Furthermore, percussion retouch would be nearly impossible to realize on such objects because of their low inertia, which makes them difficult to stabilize under the force of percussion.

The small removals from the back-line of the lunates can be easily detached using the pressure
retouching technique. With this technique, a short bone tool is held in one hand, while the lunate is squeezed between the fingers and palm of the other hand (Fig. 17:A), or pressed with a finger against the knee (Fig. 17:B) or the side of the heel (see also the tests from D. Helmer in Stordeur, 1988).

The question remains as to whether the flint blank, a thin bladelet or flake with at least one regular edge (the opposite edge being the one that is retouched), could be shaped only by this short oblique pressure retouching technique. This is certainly the case for the distal end of the blank, which is very thin. Shaping the proximal end of the flint blank, however, requires more work since the whole butt and most of the bulb must be removed, as we observe on the archaeological samples. It is thus necessary to reduce the proximal end of the blank either progressively by bifacial pressure retouch, or more rapidly by direct or inverse percussion with the edge of a small flat pebble (see Fig. 5:3 with lower half first shaped by inverse percussion, and Fig. 5:5 with the tip showing an early inverse truncation). Microburins could be produced using the latter option (a *piquant-trièdre* is still visible on two lunates in our sample, which also includes 17 microburins, some of them inverse (cf. Valla, 1984, fig. 26:17). In this case, the toolmaker had to use some sort of support, such as a piece of wood placed on the knee or on the ground. Experimentally, this preliminary truncation or microburin fracture of the proximal end of the blank only takes a few seconds.

The following oblique pressure retouch used to shape the back line of an Early Natufian lunate is an effective technique because it can always be easily carried out by alternating short sequences of removals, the condition being to keep the edge centered within the section of the blank (if the retouch becomes too steep on some part of the edge, the progression gets more difficult). This technical condition recalls the observation that the bifacial retouch of lunates generally starts with a short direct series before turning the piece for an inverse series (Fig. 18). A schema illustrates how this process is more effective to center the retouched edge in relation to the blank’s plane of bifacial symmetry (Fig. 19). Starting with direct removals (after a slight abrasion of the edge) helps
Starting with **direct** retouch

The retouched edge is **almost centred** in relation to the plane of bifacial symmetry

Starting with **inverse** retouch

The retouched edge is **not centred** in relation to the plane of bifacial symmetry

---

**Fig. 19.** Starting the Helwan retouch: A – with direct removals it is the more effective solution to center the retouched edge in relation to the plane of bifacial symmetry of the blank; B – with inverse removals

---

To produce asperities on which the pressure tool will be set so as to detach thicker inverse removals during the following inverse series. In this way, the plane of the modified edge will move toward the mid-line of the section, thus facilitating the next direct removals, which may run “under” the upper arise of the blank.

On the contrary, starting with inverse retouch on a fresh edge would only produce very thin removals, which do little to center this edge. Thus the following direct removals will face a semi-abrupt profile and tend to hinge before the upper arise. The retouched edge obtained will be asymmetrical and will remain so even after further inverse and direct removals.

If the back edge is kept centered during shaping, a bifacial oblique retouch (forming a 45° to 60° angle with the section plane) can be easily produced by pressing on the “teeth” left in between previous scars detached on the opposite face. This explains the regularity of the rhythm of removals observed in some of the lunates (Fig. 5:7, Fig. 16). However, if the toolmaker does not pay attention to a thicker spot from the dorsal face of the blank (arise), or from its ventral face (residual portion of the bulb), which would require the pressing of larger and thicker removals, the back edge will deviate from the center and become asymmetrical. In this sense, a few of these lunates seem to be carelessly shaped: for example the object shown in Fig. 5:8 or Fig. 5:4 has a residual prominence on the dorsal face that would be easy to remove (on the top left of its drawing). A few more seconds of shaping or a little more care for the last removals would have easily allowed a better rectification of the back edge. This suggests that the hafting method did not require a strict morphology of the back-edge.

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Other “way of doing” or circumstantial variants?

The few lunates from the Early Natufian level of Eynan that bear abrupt or vertical retouch, either along the whole of the back edge or alternating along two or three portions of it, seem to indicate a “way of doing” that differs from Helwan retouch. Indeed, following this option of more abrupt retouch, the toolmaker deviates from the Helwan option since it is difficult to recover a symmetrical and centered back edge once this edge has been steeply bevelled on one side.

Two different circumstances could lead an Early Natufian lunate toolmaker to shape some back edges with a more abrupt or vertical retouch. In the first case, the selected blank is thin and narrow so that there is very little volume to shape out once the proximal end has been removed by percussion. The toolmaker might then continue with the stone retoucher he has at hand and just scratch the rest of the thin back edge that has to be shaped. In one or two quick passes, a thin abrupt to vertical back will be produced in a direct or in-
verse position. Such an option could then be con-
considered a “simplified variant” of the process,
“short cutting” the final Helwan retouch. This
could account for the few lunates with a thin back
shaped by unidirectional direct retouch leading,
after two or three repeated series, to a rather
abrupt or vertical back, such retouch being made
by percussion on a support or by pressure (see the
four thin lunates of medium-small size, such as
Fig. 6:3).

However, a few lunates that bear only one se-
ries of oblique pressure retouch for the shaping of
a relatively thin back edge (for instance Fig. 6:7),
demonstrate that the “simplified variant” — that is
finishing a thin back by scratching — was not a
common response to a thin and narrow blank: it
therefore seems that different toolmakers reacted
different technical habits. In a contrasting situ-
ation, when working with a large and thick blank,
which would render pressure retouch laborious if
not impossible (within its usual Helwan range),
the toolmaker might be tempted to extend the ini-
tial truncation produced with the stone retoucher.
One lunate suggests such an explanation: its thick
proximal end was first shaped with oblique re-
movals before being finished with vertical and
even crossed retouch (Fig. 6:6 with the distal half
of the back edge shaped by short abrupt retouch,
possibly scratched with the stone retoucher).

Yet another lunate (not figured) seems to
have been abandoned in a technical deadlock after
a few direct removals failed to reduce its thick
back, which turned locally vertical. The tool-
maker then attempted to continue with crossed re-
touch but did not succeed. Such crossed retouch
would have been possible using a stone on a firm
support. The failure thus suggests that at this
stage, and on this particular lunate, this particular
toolmaker was working by pressure in his hands,
meaning with the Helwan technique.

Other “way of doing” significantly different
from the Helwan mode

Meanwhile, keeping these two latter “expla-
nations” in mind, the back of some other lunates
was shaped in a way that seems to differ signif-
ically from the Helwan mode. The seven lunates
with a thick vertical back described above were
completely or mostly shaped by stone percussion
on a support. The retouch was direct (Fig. 6:10,
12–13), mostly inverse (Fig. 6:9) or even crossed
(Fig. 6:11), the latter with two subsequent flat
verse removals by pressure. The shaping of the
smallest of them (Fig. 6:13) definitely required a
specific support, as will be described later for the
Final Natufian lunates from which this tiny lunate
can barely be differentiated (possibly intrusive
from the upper level?).

A few other lunates bear a locally unidirec-
tional and abrupt to vertical retouch, but alternat-
ing along the back, more precisely with one end
shaped direct and the other end shaped inverse
(Fig. 5:1, 12, 14; Fig. 18). The two lunates figured
(Fig. 5:12 and Fig. 5:14) seem to have been made
by percussion (the latter possibly with the lower
end scratched), but the pressure technique seems
to have been used at least on a portion of the back
of two other similar lunates (not figured).

Whatever the technical explanation of these
latter lunates, with the backs finished in a mostly
vertical position, combined with the dominant or
exclusive use of percussion on a support, these
observations show that although the Helwan
mode of back shaping was dominant, it was may
be not the only technique known and practiced by
the toolmakers of this particular collection of
Early Natufian lunates.

FINAL NATUFIAN GEOMETRIC
MICROLITHS/LUNATES

The sample (O.M.)

The geometric microlith sample is very small,
with just 30 artifacts, including 20 lunates and 10
triangles. An additional group that was only par-
tially analyzed consists of 12 lunates that were
probably intrusive from the older Natufian levels.
Four fragments of geometric microliths (usually <
5 mm in length), most of them burnt, were also
excluded from this analysis.

Most of the 30 lunates with certain stra-
tigraphic attribution are small (< 14 mm long) and
usually modified by direct (N = 15; 50%) or oc-
casionally by crossed (N = 8; 26.7%) or alternating
retouch (N = 7; 23.3%). Vertical retouch (N = 25;
83.3%) is dominant while abrupt and oblique ret-
touch are uncommon (4 abrupt, 1 oblique). In
contrast to the Early Natufian assemblage, these
microliths were not separated into bladelet and flake blanks since more than half of the objects within this group were designated as indeterminate blanks ($N = 16$).

During the analysis, these 30 microliths were divided into two sub-groups. The first, sub-group ($N = 21$: 70% of the geometric microliths; Fig. 20:1–10) includes objects that are modified almost exclusively by vertical retouch (95.2%). They are considered to be the end-products of microlith production. The second sub-group ($N = 9$: 30% of the geometric microliths) includes pieces that are irregular in shape and dimensions (Fig. 20:11–16; Fig. 21). These objects also bear direct, alternating or crossed retouch but the retouch angle is not necessarily vertical (44.4%) and is occasionally abrupt (44.4%) or even oblique (11.2%). These pieces are probably microliths that were discarded during preparation.

An additional group consisted of 12 lunates

---

Fig. 20. Lunates and triangles from the Final Natufian layer at Eynan. Drawings by L. Zieger. Note impact damages on 5 and 7
that were excluded from the analysis. Eleven of them were considered to be intrusive (Fig. 22:1, 3) and 1 that was suspected to be intrusive was also omitted from the study out of caution (Fig. 22:2). Most of these pieces could have originated from the Early Natufian level (i.e., those displaying Helwan retouch), while some could also have originated from the Late Natufian level. The majority ($N = 9$) display Helwan retouch sensu lato, i.e., usually non-vertical bifacial oblique or alternating retouch (Fig. 22:1). An exception is a large lunate ($27 \times 12 \times 4$ mm) that was modified mainly by vertical-alternating retouch, while its distal tip was formed by bifacial oblique retouch (Fig. 22:3). The remaining three lunate display alternating vertical or crossed retouch, which is also common within the Final Natufian assemblage. However, all of these lunate are distinctly longer (>10 mm), wider (2–3 mm), and have a higher radius (5–8 mm) than the average in the Final Natufian geometric microlith group (Figs. 23–24). Additionally, they are slightly slender (one mm average) but almost identical in length, thickness, length/width ratio (less than half mm in average) and length/radius to the Early Natufian, Helwan sensu lato group (Tables 1, 14; Fig. 24).

**General description**

Of the 30 lunate and triangles retrieved, 26 are complete (86.7%) and four are broken. Only one burnt object was analyzed.

The raw material used for Final Natufian geometric microliths is similar in texture and quality to that used in the Early Natufian sample. Two lunate were made from chalcedony. Five pieces retain minute signs of chalk inclusion. It is interesting that three of these objects were found among the “geometric microliths in preparation” group, indicating that these inclusions were one of the causes for their discard during the first sequence of microlith production (see “Retouching Methods”).

![Fig. 21. Length/width of Final Natufian lunate and triangles. Artifacts in preparation vs end-products](image)

![Fig. 22. Possibly intrusive lunate from the Final Natufian layer at Eynan. Drawings by L. Zieger](image)
Fig. 23. Length/radius of Final Natufian lunates and triangles.

Fig. 24. Length/radius of Early Natufian lunates. Addition of Fig. 7 and Fig. 8.
Reconstructing microlith shaping

Table 14

Metric characteristics of Final Natufian lunates

<table>
<thead>
<tr>
<th>Lunate groups</th>
<th>Average length (mm)</th>
<th>S.D. C.V.</th>
<th>Average width (mm)</th>
<th>S.D. C.V.</th>
<th>Average thickness (mm)</th>
<th>S.D. C.V.</th>
<th>Average length/width</th>
<th>S.D. C.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometric microbl. all N = 27, 30, 30, 27</td>
<td>11.19</td>
<td>1.90</td>
<td>5.63</td>
<td>2.20</td>
<td>2.57</td>
<td>0.90</td>
<td>2.21</td>
<td>0.66</td>
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<td>minimum</td>
<td>7.00</td>
<td>0.17</td>
<td>3.00</td>
<td>0.39</td>
<td>1.00</td>
<td>0.35</td>
<td>0.50</td>
<td>0.30</td>
</tr>
<tr>
<td>maximum</td>
<td>14.00</td>
<td>3.13</td>
<td>13.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>3.30</td>
<td>1.17</td>
</tr>
<tr>
<td>Geom. end-products N = 18, 21, 21, 18</td>
<td>11.28</td>
<td>1.90</td>
<td>4.77</td>
<td>0.97</td>
<td>2.24</td>
<td>0.70</td>
<td>2.55</td>
<td>0.44</td>
</tr>
<tr>
<td>min.</td>
<td>8.00</td>
<td>0.17</td>
<td>3.00</td>
<td>0.21</td>
<td>1.00</td>
<td>0.31</td>
<td>1.80</td>
<td>0.17</td>
</tr>
<tr>
<td>max.</td>
<td>14.00</td>
<td>3.13</td>
<td>13.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>3.30</td>
<td>1.17</td>
</tr>
<tr>
<td>Geom. in prep. N = 8, 9, 9, 8</td>
<td>10.75</td>
<td>1.98</td>
<td>8.00</td>
<td>2.60</td>
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<td>0.87</td>
<td>1.45</td>
<td>0.46</td>
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<tr>
<td>min.</td>
<td>7.00</td>
<td>0.18</td>
<td>6.00</td>
<td>0.32</td>
<td>2.00</td>
<td>0.26</td>
<td>0.50</td>
<td>0.32</td>
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<tr>
<td>max.</td>
<td>13.00</td>
<td>3.13</td>
<td>13.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>3.30</td>
<td>1.17</td>
</tr>
<tr>
<td>Geom. intrusive N = 7, 11, 11, 7</td>
<td>22.00</td>
<td>3.46</td>
<td>8.18</td>
<td>2.23</td>
<td>2.64</td>
<td>0.81</td>
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<tr>
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<td>6.00</td>
<td>0.27</td>
<td>2.00</td>
<td>0.31</td>
<td>2.00</td>
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<td>2.00</td>
<td>3.00</td>
<td>5.00</td>
<td>3.00</td>
</tr>
</tbody>
</table>

The most noticeable result of the qualitative and metric analysis (see detailed information in Table 14) is the striking differences detected between the 21 endproducts and nine microliths abandoned during preparation. First, metric comparison between these two groups indicates that the objects in preparation were rejected after their length was reduced by systematic truncation to the more or less correct length, though they were still much wider, thicker and robust than the desired blank form (Table 14).

The blanks of most lunate and triangle endproducts exhibit a unidirectional scar pattern (N = 18; 84.2%). However, since usually only one or two scars were preserved it was impossible to determine if the exact scar direction was unipolar straight, convergent or divergent. A multidirectional simple and side scar pattern appear only rarely (15.8%). Additionally, these artifacts display between zero to two arises, which are straight and usually non-parallel to the cutting edge. As described above, most of the blank types could not be determined. Meanwhile, among the defined blanks, eight are bladelets and two are flakes.

The geometric microbliths in preparation most often display a multi-directional, irregular or simple and side scar pattern. These artifacts exhibit between zero and two arises with non-parallel cutting edges. The cutting edge is straight on only five objects (55.4%), while the others are characterized by an irregular cutting edge. All the identified blanks (four cases) are flakes while the remaining blanks were designated as indeterminate (five cases).

Scars resulting from the microburin technique on the proximal or distal end of the geometric microlith endproducts are infrequent (19%). This is important since, in contrast, piquants-trièdres are visible on 75% of the nine artifacts in preparation, indicating that this technique was much more common than can be concluded through analysis of the completed microliths. This discrepancy between the two samples is mainly due to the fact that following the initial truncations by the microburin technique, a secondary retouch covered the microlith ends (see "Retouching Methods"), which made the identification of piquant-trièdres difficult and in many cases impossible.
touch was described: this was considered as an important criterion to determine the rate of retouch regularity as a characteristic of the specific technique used at the site. Since these objects appear only randomly within the Early Natufian assemblage, and by contrast are more common in the Final Natufian sample, this criterion was systematically observed only on the latter assemblage.

It was difficult to observe the delineation at the intersection of the back and the ventral face of the microliths since it bears numerous hinged micro-scars. A theoretical line was thus drawn in the middle of the back of the lunates in a place where the micro-delineation was easier to register (Fig. 25). Technically, in order to determine the character of the delineation (e.g., regular, irregular, deeply irregular) an extendible bronze cord was used. The given delineation, which became visible on the cord, was then drawn. This was a simplified method of globally estimating the average depth of the scars, which is impossible to measure precisely with conventional equipment. In the future we intend to resolve this problem through image analysis.

In general, the modification of lunate and triangle endproducts was achieved through very regular and standardized retouch of the back. This standardization is shown by the regular micro-delineation of the back, dense scar pattern and narrow largest scar.

This delineation of the back of endproducts is regular to very regular, forming a theoretical straight line (76.2%). Pieces displaying slightly irregular to irregular delineation are less common, creating a wavy or zigzag abstract line (23.8%; e.g., Fig. 20:1). In contrast, the delineation of the back of microliths in preparation is irregular, creating a deep concave or deep zigzag abstract line (six cases; e.g., Fig. 20:12, 14), while a regular delineation is less common (three cases; e.g., Fig. 20:11).

The retouch uniformity and density ratios of geometric microlith endproducts are $0.46 \pm 0.39$ mm and $0.70 \pm 0.17$ mm respectively. The average width of the largest scar is $1.48 \pm 0.87$ mm. Conversely, the geometric microlith in preparation group displays much less uniform and more diffused density ratios ($1.17 \pm 0.85$ mm and $0.44 \pm 0.12$). In addition, the largest scar average of
this sub-group is much wider at 3.11 ± 1.69 mm. In sum, geometric microlith endproducts are more standardized in size than microliths in preparation; they are distinctively elongated, narrower and slender in dimension. In addition, they are perhaps made from more regular blanks (preference for bladelets?), displaying a mostly uni-polar scar pattern with a straight cutting edge. The back was formed by a much more regular retouch, which created a regular, straight delineated back.

Impact damage

Two artifacts with impact damage were identified in the geometric microlith endproducts assemblage (9.5%; 6.7% from the total assemblage; Fig. 20:5, 7), while no artifacts displaying this type of modification were found among the geometric microliths in preparation.

One damaged microlith is intensively burnt, displaying color change, potlids cracks and shattering. Both display transversal, burn-like impact damage on their distal end. It is important to note that this type of impact damage is identical to that observed on the lunates from the Early Natufian level at Eynan (see Fig. 5:12, Fig. 6:11).

Retouching methods (B.V.)

As mentioned above, we suspect 12 microliths of being intrusive in the assemblage selected for this study. Nine of them display Helwan retouch sensu lato (Fig. 22:1) and the method of manufacture corresponds exactly to the main one described for the Early Natufian assemblage. The other probably intrusive microliths, indicated by their size, are characterized by very abrupt retouch, which could result from a method other than the Helwan method (Fig. 22:2–3). However, since these microliths with abrupt retouch are very rare, we cannot reconstruct their method of manufacture. We must simply recall that our Early Natufian sample includes analogous, very ambiguous, microliths that are similar to the Helwan lunates in terms of their morphometrical aspects but distinct if we consider the obliquity of their retouch. To verify a working hypothesis inspired by the rather complex taphonomy observed at Eynan, we suggest confirming in the future whether such “hybrid” lunates are abundant in Late Natufian levels.

How many methods for the 30 geometric microliths correspond to the main component of this assemblage?

After exclusion of the 12 problematic microliths, we are left with 30 objects with some (but not all) shared characteristics. In the analyses described above, we have already taken the risk of establishing a basic distinction between those microliths that were supposedly discarded during preparation (“roughouts”; Fig. 20:1–10) and those considered as final endproducts (Fig. 20:11–16). In other words, we consider that these two categories of objects are the result of two stages of a single method of retouch, and not the products of two distinct methods (this latter hypothesis would imply that the irregular microliths were intentionally produced). In support of our hypothesis, we note evident similarities between the two categories: identical lengths (Fig. 21) and the presence of piquants-triédres in both cases. At the least, these common features reveal a conformity concerning both dimensional goals and technical solutions. However, other features could support the opposing hypothesis of distinct purposes: these are distinct widths (Fig. 21) and morphologies (triangular for 66% of possible roughouts and for only 14% among “endproducts”). Of course, there is also an important difference concerning general aspects of the retouch.

If we take into account each of these differences without consideration for the technical logic that we hypothesize, we must recognize that these differences could be used as arguments for the distinction of two types of microliths, or at least two sub-types. In these cases, our nine possible “roughouts” should rather be considered as simplified versions of the main type, exemplified by the 21 other microliths.

However, the two unquestionably used microliths belong to this latter category of carefully made microliths (Fig. 20:7). In addition, if the general aspects of retouch are certainly different, we should nonetheless note that four microliths among the nine possible roughouts, which display globally irregular retouch, also bear some carefully made removals with very narrow scars on a small part of their back (Fig. 20:13–14). All things considered, our principal argument is that our hypothesis, according to which these two
categories of microliths reflect two stages of a single *chaîne opératoire*, allowed us to reconstruct a very consistent method, which actually introduces a good accordance between some of the distinct aspects that we described above.

This method, as we have reconstructed it, was easily reproduced experimentally by J. Pelegrin. Though this reproduction is certainly not a definitive demonstration, it proves that the transformation from one stage (roughouts) to another (end-products) is very easy. The main interest of this experimentation was to illustrate the unquestionable advantages of such a method for archaeological goals. The tests show, for example, that it is usually necessary to change retouching tools in order to attain the extremely small widths of the microliths we consider as end-products without breaking them. This is a new argument for a strong link between our two categories. One could object that this connection is not necessary if we assume that what we called “roughouts” were in fact relatively wide, carelessly made end-products. On the other hand, a stronger connection exists in the other sense since experimental reproductions show that the products we considered as finished were very difficult to obtain without a previous stage of modification, except if Natufian toolmakers would have accepted producing disproportionate efforts (see further considerations about “Retouching Techniques”).

A method with two main sequences

While it is possible to divide the main Early Natufian method into successive series corresponding to a progressive transformation of the blank from each face, it is not possible to analyze the main method in the Final Natufian with the same precision (Fig. 26). For this reason, its description is less detailed. The retouch is very abrupt from the beginning and each series tends to erase the previous one. Therefore, successive gestures cannot be reconstructed, as we nearly succeeded in doing for some Early Natufian microliths. On the Final Natufian objects, we can observe only gross stages of manufacture according to our model based on two main successive states of transformation (first “roughing-out” and then “finishing”). Consequently, the notion of “Series” is too precise for such distinct states, considering their goals and technique (see below). In this context, “Sequence” is a more accurate term according to the definition given by J. Pelegrin, “During the succession of removals (...), a change in operation and/or technique allows a subdivision into sequences” (1995:23 — our translation). To summarize, the main method in the Final Natufian consists of two sequences, each composed of several series, which are impossible to distinguish.

A first sequence for roughing-out (Fig. 26A). As noted above, nine microliths seem to have been abandoned during the first sequence (Fig. 20:11–16) and their examination sometimes reveals the size of the blank selected. Along a few millimeters of the retouched edge, the original width of some roughouts was almost entirely preserved: it is nearly 10 mm (Fig. 20:16) and this dimension corresponds to the original one preserved on some of the Early Natufian lunates. Considering their degree of modification by retouch, some of the endproducts could result from blanks with similar widths (Fig. 20:1–4), while some others were clearly manufactured on narrower blanks (Fig. 20:5–10). The metric analogy with Early Natufian blanks is stronger if we consider the thickness, which is preserved on every microlith (Tables 1, 14). To summarize, the differences between the blanks selected in the Early and Final Natufian are not very pronounced. We will return to this question in the conclusion.

In the Final Natufian, the first stage of transformation was performed by stone percussion (see below “Retouching techniques”) used to “prune” the original blank. This consists of removing a sizeable portion by blows, which were often deeply struck. At this stage, the original length was reduced to already coincide with that of the endproducts. Pruning consists of two truncations made by deep, direct or inverse removals struck at right angles to both faces of the blank. These perpendicular removals were associated with rather short, oblique breakages obtained by the microburin technique. This combination is observed on 8 roughouts showing one or sometimes two *piquant-trièdres*. This is proof for a clear continuity in gestures: varying the position of the blank to the support (see “Retouching techniques”), the toolmakers could easily control the obliquity of the removals. Due to this control,
pruning of the blank could be progressive, consisting of repetitive microburin breakages. According to experiments, this procedure reduces the risk of unexpected breaks. The preparation of each microlith thus generates by-products that are numerous and varied: regular microburins, "Krukowski" microburins, and simple micro-flakes, which can be easily confused with the results of other retouching process. At first sight, this diversity fits well with the observations of previous studies concerning the Final Natufian industry of Eynan (Valla, 1984; Valla et al., 1999, 2001, 2004). However, the whole industry includes by-products from more than one retouching process, and, among others, from the processes used for shaping numerous non-geometric microliths. This is the main difficulty encountered in systematic studies of this type of archaeological by-products that go beyond simple inventories. We have not yet attempted such a study because we believe it requires new experimental tests in order to better define the criteria that can be used to recognize the typical by-products of geometric microlith production. Though such a study would probably be difficult, it could lead to an even more detailed reconstruction of retouching methods, including a possible differentiation of several successive series within the roughing-out stage. It could be also an opportunity to examine the exact limit, in this context, between regular microburins and "Krukowski" ones. Do they result from different operations, or, in this specific context, are they variants of each other?

One can also wonder about the precise goal that led to the use of microburin technique sensu lato. Is this technique simply a fast and easy way to segment blanks, or is it also intended to obtain sharp extremities? Our sample provides some answers: intentional sharpening seems to be probable if we take into account some of the identified reasons for discards. Raw material heterogeneities could play a role in some cases, but the reason seems to be most often related to the sudden loss of sharpness at one of the points. Several artifacts actually exhibit a tip that was slightly broken at this stage of transformation (Fig. 20:11–12, 14–15) or that became too obtuse due to excessively deep retouch (Fig. 20:13, 16). In the latter case, the irregularity of such a retouched edge was an additional reason for discard because it compromised the final completion of the products.

At this stage of roughing-out, it seems that the adjustment of the length, and perhaps also the shaping of two acute extremities, are the main goals. A reduction in width is also noticeable along 2/3 of the edge, which was transformed by clearly oblique truncations creating a triangular shape on most of the artifacts (Fig. 20:13–16). From triangle to lunate, the remaining work consists of obtaining a curved edge and narrowing the
Fig. 29. Retouch characteristics: Final Natufian lunate rough-outs (drawn respectively Fig. 20: 11 and 12), left at the stage of back reduction by stone percussion on a support (because they lost one of their points). Note the deep and large negatives. Photos by L. Klaric and J. Pelegrin.

Fig. 30. Retouch characteristics: 1, 2 – Final Natufian finished lunates, with a regular back obviously finished by pressure; for comparison, two experimental lunates: 3 – finished by stone percussion on a firm support; 4 – finished by pressure on a firm support with a bone tool. Photos by L. Klaric and J. Pelegrin.
As with percussion, the use of a firm support explains why a few of these last pressure removals show a discrete distal hinging, instead of a thin, overpassing as they would if they did not reach a firm contact. Finishing the back of the thickest lunate with crossed retouch can thus produce a particular vertical, convex section (crossed retouch is not spontaneously produced by a bipolar mechanism, as sometimes suggested: the toolmaker must rotate the roughout so as to detach each crossing removal).

Technical differences between Early and Final Natufian techniques

The know-how (skill) involved in the production of typical Final Natufian lunate can be estimated as slightly higher than that involved in the production of Early Natufian lunate because toughing-out Final Natufian lunate requires good control of the microburin fracture, which is not easy with such small objects.

Another difference lies in the tools used as a support for the shaping and finishing of small Final Natufian lunate. Special tools were probably necessary (Figs. 28–30), while Early Natufian lunate could be made using a simple piece of wood for the easy preliminary truncation or microburin fracture of the proximal end of the blank. Helwan pressure retouch can also be considered as an easier technique than the vertical crossed pressure retouch of the Final Natufian, which allows for little tolerance in precision: if the tip of the pressure tool is placed above a minute overhang from a previous removal, the edge will be crushed, and detachment of a new removal from this spot will become more difficult (having to place the tip deeper inside the edge) and risky (a second crushing will definitely “close” the edge at that point).

DISCUSSION

Retouch characteristics (O.M.)

In this study, we have attempted to characterize the regularity of the back retouch on Natufian geometric microoliths, mainly lunate. We began with a preliminary qualitative definition, followed by a quantitative approach that measures retouch density and uniformity. Though our results are stimulating, they are far from conclusive. At the intra-assemblage level, in the Early Natufian sample, we observed differences in the rate of retouch regularity according to blank type (bladelets versus flakes) and between the dorsal and ventral faces of lunate. These differences are correlated with blank regularity, gesture type and intentions.

In the Final Natufian sample, we observed numerous differences between the geometric microolith endproducts and artifacts that were probably abandoned during production. The endproducts clearly display denser retouch scar ratios and much smaller retouch scars. Their blanks are more regular in shape and size and they have a unipolar dorsal scar pattern, a straight cutting edge, a straight back profile delineation, and fewer piquant-triédres.

The inter-assemblage differences between Early Natufian and Final Natufian samples are more ambiguous and thus more difficult to interpret. The two assemblages show the same rate of retouch regularity (Tables 16–18). This ambiguity is due to the fact that a large portion (ca. 30%) of the Final Natufian assemblage consists of microoliths in preparation, which decreases the overall regularity of the sample. A different picture arises when possible microoliths in preparation are eliminated from both assemblages. The Final Natufian endproducts then display a much higher degree of retouch regularity (85.7% versus 69.3%; Table 18), a higher uniformity ratio (0.46 ± 0.39 mm versus 0.96 ± 0.93 mm), a higher density ratio (0.70 ± 0.17 mm versus 0.58 ± 0.16 mm) and much smaller scars on average (1.48 ± 0.87 mm versus 2.49 ± 1.33 mm).

At this point it is tempting to suggest that the differences in retouch regularity between the Early and Final Natufian assemblages reflect differences in technique, between for example, a more “basic” process in the Early Natufian and more elaborate ones in the Final Natufian. However, the indices used in our discussion do not appear reliable for the immediate recognition of techniques (e.g., stone retoucher versus pressure). First, the attributes we considered only partially describe the metric characteristics of the retouch. Other attributes, such as retouch depth, which must be measured through image analysis, were too superficially registered, despite their probable significance. Moreover, many of the qualitative attributes used are based on an experimental reference base that is still too small to allow more
Table 16

Early Natufian: retouch regularity frequency in the whole assemblage

<table>
<thead>
<tr>
<th></th>
<th>Early Natufian Whole assemblage**</th>
<th>Early Natufian Helwan lunates**</th>
<th>Early Natufian Other lunates**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dorsal &amp; ventral faces</td>
<td>dorsal &amp; ventral faces</td>
<td>dorsal &amp; ventral faces</td>
</tr>
<tr>
<td>Regular</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>77</td>
<td>70.0</td>
<td>67</td>
</tr>
<tr>
<td>Irregular</td>
<td>33</td>
<td>30.0</td>
<td>28</td>
</tr>
<tr>
<td>Total *</td>
<td>110</td>
<td>100.0</td>
<td>95</td>
</tr>
</tbody>
</table>

*When the regularity attribute was “indeterminate”, items were excluded from the analysis
**Including items the original blank of which could not be determined

Table 17

Final Natufian: retouch regularity frequency in the whole assemblage

<table>
<thead>
<tr>
<th></th>
<th>Final Natufian Whole assemblage**</th>
<th>Final Natufian Geometric microliths end-products**</th>
<th>Final Natufian Geometric microliths in preparation**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Regular</td>
<td>26</td>
<td>66.7</td>
<td>18</td>
</tr>
<tr>
<td>Irregular</td>
<td>10</td>
<td>33.3</td>
<td>3</td>
</tr>
<tr>
<td>Total *</td>
<td>30</td>
<td>100.0</td>
<td>21</td>
</tr>
</tbody>
</table>

*When the regularity attribute was “indeterminate”, items were excluded from the analysis
**Including items the original blank of which could not be determined

elaborate statistical analyses (e.g., cluster analysis). Therefore, we cannot propose a restricted list of attributes that could be systematically used in other archaeological contexts. Nonetheless, we consider the indices concerning density and uniformity to be effective tools for further comparisons at intra- and inter-assemblage levels since they can reduce the ambiguity inherent in the superficial use of terms such as “regular” or “irregular” to describe retouch characteristics. For example, these indices could be useful for comparing the apparently less “regular” Helwan lunates from Eynan with the apparently more regular ones from southern Jordan and the western Negev.

At this stage of research, inter-assemblage comparisons remain difficult since they could be based mainly on illustrated material, which naturally focuses on specific parts of the lunate and triangle samples (e.g., Byrd, 1989; Goring-Morris, 1987). For this reason, we chose to focus on the specific domain of blank selection for Helwan lunate production, for which we recorded some data through previous personal analyses (Marder, 2003). At Eynan, bladelets with a rectilinear profile and straight parallel cutting edge were probably preferred for lunate production, though a considerable number of flakes were also selected. The retouch regularity of lunates made on bladelets is obviously greater than that of lunates made of flakes. It also seems that this phenomenon is more pronounced in Early Natufian assemblages in southern Jordan (Beidha, Byrd, 1989) and Terminal Ramonian/Early Natufian assemblages in the western Negev (Azariq XV, Nahal Sekher 23, Shunera VII, Goring-Morris, 1987; Marder, 2003). These assemblages are highly dominated by the production of regular blade/lets, which are mainly used for microlith manufacture. At these sites, it seems that lunates display a more uniform modification, which is
Early and Final Natufian: retouch regularity attributes in the whole assemblages

<table>
<thead>
<tr>
<th></th>
<th>Retouch uniformity</th>
<th>S.D.</th>
<th>Retouch density</th>
<th>S.D.</th>
<th>Largest scar width</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Natufian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole assemblage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 100, 105, 99</td>
<td>1.10</td>
<td>0.97</td>
<td>0.57</td>
<td>0.17</td>
<td>2.73</td>
<td>1.52</td>
</tr>
<tr>
<td>Helwan lunesates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 81, 81, 75</td>
<td>0.93</td>
<td>0.93</td>
<td>0.58</td>
<td>0.16</td>
<td>2.44</td>
<td>1.47</td>
</tr>
<tr>
<td>Early Natufian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luteses in preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 11, 11, 11</td>
<td>1.38</td>
<td>0.94</td>
<td>0.43</td>
<td>0.18</td>
<td>3.90</td>
<td>1.22</td>
</tr>
<tr>
<td>Final Natufian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole assemblage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 30, 30, 30</td>
<td>0.67</td>
<td>0.64</td>
<td>0.61</td>
<td>0.20</td>
<td>1.97</td>
<td>1.38</td>
</tr>
<tr>
<td>Final Natufian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometric microliths</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>end-products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 21, 21, 21</td>
<td>0.46</td>
<td>0.39</td>
<td>0.70</td>
<td>0.17</td>
<td>1.48</td>
<td>0.87</td>
</tr>
<tr>
<td>Final Natufian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometric microliths</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 9, 9, 9</td>
<td>1.21</td>
<td>0.85</td>
<td>0.44</td>
<td>0.12</td>
<td>3.11</td>
<td>1.69</td>
</tr>
</tbody>
</table>

characterized by a bifacial oblique retouch that often extends onto both faces along the entire length of the pieces. It is possible that these variations are mainly related to the fact that bladelet blanks are morphometrically more standardized and are therefore more regularly modified by retouch in comparison to flakes. It is also possible that these differences reflect, for example, the procurement and exploration of different types of flint (e.g., regular fine-grained flint from Eynan vs. chalcedony from southern Jordan and the Negev). However, at this stage of research, our knowledge is still insufficient to answer these questions.

The importance of the microburin technique

In accordance with Valla’s previous hypothesis, we indicated that the microburin technique was habitually used during the Final Natufian at Eynan to reduce the length of geometric microliths through sequential removals of regular and Krukowski microburins. Based on the lithic assemblage analyzed, two lines of evidence confirm this hypothesis. One is the increased frequency of microburins (especially Krukowski) from the Early Natufian to the Final Natufian at Eynan (Valla, 1984). The second is the high number of piquant-trièdres on geometric microliths (on both endproducts and microliths in preparation) during the Final Natufian in contrast to their rarity in the Early Natufian (36.7% versus 3.6%).

However, if the microburin technique was habitually used during the Final Natufian at Eynan, as we predict, the hypocly index is low in comparison to the expected number of these objects according to experimental tests by J. Pelegrin. In these tests, during lunate production, successive ordinary microburins were produced at each end of the blank (Fig. 31:1 for an atypical example). A large range of Krukowski microburins was also produced (Fig. 31:2–5). These include typical
Krukowski microburins, some with a truncation, convex back and a scar (Fig. 31:2), and atypical Krakowski microburins. These were made on side-struck flakes with wavy, triangular or elliptical platforms. A minute notch, which looks like "micro-chipping" appears on the ventral face of the blank. However, based on our reconstruction, these objects are residues of the truncation of microliths (Fig. 31:4–5). Finally, ordinary chips were also produced during this process. It is clear that the two latter spall types were not always included in the microburin sample, resulting in an underrepresentation of the microburin technique in the Final Natufian assemblage.

Methods (B.V.)

On several occasions, we emphasized differences in the degree of care employed in lunate production during the Early and Final Natufian. These differences are clearly related to different retouch modes, but also to two distinct conceptions of the process of transforming blanks that were originally quite similar (i.e., bladelets or small flakes with analogous width and, above all, an unchanged thickness).

During the Early Natufian, the microburin technique was perhaps initially used in some cases. However, this technique seems to be rare at Eynan and not necessarily related to sharpening the tips, as it is during the Final Natufian. In the Early Natufian, a progressive method was used to give microliths their appropriate dimensions. Using this method, the shape of the object was determined through a gradual regularization of the back. The risk associated with this method is low, as is demonstrated by the low proportion of accidental breaks. Where the greatest care was needed was to preserve a thin retouched edge until the end of the transformation process, sometimes with only restricted and local corrections. This attention paid to the constant thinness of the edge, which was supposed to be hafted, is the most impressive particularity of the Helwan sensu lato method. In contrast, in a close chronological context and for analogous morphometrical goals (arched backed bladelets with similar dimensions), Mushabian and Early Ramonian industries display abrupt retouch instead of the constant obliquity that is specific to the Early Natufian.

Fig. 31. Experimental by-products resulting from a roughing-out sequence analogous to the sequence performed on Final Natufian lunates. Experiment by J. Pelegrin. Drawings by L. Zieger (Goring-Morris, 1987; Bar-Yosef and Phillips 1977; Marks and Simmons, 1977).

As for the Final Natufian method, it clearly dissociates the two aims of the work, shaping and regularization, into two stages performed by distinct retouching techniques (Fig. 26). The aim of the first sequence was to reduce the blank in order to retain the required length while sharpening the extremities. The second stage resulted in extreme narrowing while forming the curvature of the back. Both of these stages required specific care that is clearly superior to that involved in the Early Natufian method. During the first sequence, which probably involved the most risk, the challenge was to avoid breaking the object. During the finishing stage, whose success was highly dependent on the previous stage, the main difficulty was in the manner of holding such small artifacts.

In fact, the extreme miniaturization of Final Natufian microliths is probably the principal reason behind the main changes from the Early Natufian method. The technical solutions adopted by Final Natufian toolmakers seem to be necessary in practice, considering the dimensional goals and the kind of blanks chosen. As for the finishing sequence, the combination of problems concerning the way of holding the objects and the risks of breakage definitely restrict the available choices:
the only evident solution was to use pressure on a firm support. Considering the original dimensions of the blanks and their unavoidable shortening and narrowing, the preliminary roughing-out sequence, including retouching techniques other than pressure, was necessary.

Nevertheless, considering the morphodimensional characteristics associated with Final Natufian intentions, another solution, which was completely distinct from the one performed at Eynan, was possible: different blanks, such as micro-bladelets with a width closer to that of the desired end-products could have been used. Other modes of retouch requiring less care – and why not Helwan retouch – would thus have been possible. This is the solution that was chosen in the southern French Mesolithic, for example, where the middle phase of the Sauvetterian (cf. Montclusien) is characterized by a “hypermicrolithization” (Rozoy, 1978; Barbaza et al., 1991). On the contrary, one might reasonably assume that Natufian people preferred to retain analogous methods of debitage, the original dimensions of the blanks chosen for microlith preparation and the continuity in the main modes of debitage, which do not seem to change significantly within the Eynan stratigraphy (Valentin in Valla et al., 1999; Marder and Valentin in Valla et al., 2001). Understanding the reasons for this apparent technological “inertia” presents new and stimulating challenges for future research.

Functional aspects (O.M.)

During the Natufian, at least two ways of using lunates can be discerned. One was to insert them as a tip or a barb into a composite projectile point. This is indicated by the type of impact damage observed on lunates from Eynan and Hayonim Terrace (Valla, 1987), and recently by a projectile element found embedded in a human vertebra (Bocquentin and Bar-Yosef, 2004). The second use was longitudinal insertion along the side of a shaft. This hafting pattern is shown on the “sickle” found at Wadi Hammeh 27 with intact Helwan lunates still inserted (Edwards, 1991), and on lunates from Hayonim Terrace that display sickle gloss (Anderson and Valla, 1996). A macroscopic examination of our sample revealed only the first type of utilization, though it is possible that microscopic observation also could reveal the second type. At this stage of our research we thus focus on the first utilization.

The appearance of impact damage on lunates from the Early Natufian (10.1–13.6%) and Final Natufian levels of Eynan (6.7%) is not a new or unique phenomenon. Previous studies (Valla, 1987) indicated that in the Late Natufian level of Hayonim Terrace (15.35%), as well as in the Final Natufian level at Eynan (8.9%), impact damage was present in more or less similar frequencies. However, the appearance of lunates with impact damage in both the Early Natufian and Final Natufian at Eynan is important since it indicates that most of the activities concerning microlith production are represented on-site (not necessarily on the same piece), from blank removal to backing, retouching and discard.

It is significant that both Early Natufian and Final Natufian geometric microliths display the same type of burin like damage, which in our opinion indicates that lunates were exposed in identical orientations (i.e., transversal and slightly oblique or lateral and oblique), to similar types of shock and were probably used with the same type of weapons (i.e., arrows). Consequently, it seems that there was no drastic change in the hafting mode, though some discrete options could have been modified, such as the type of groove in connection with the decline of Helwan retouch. These suggestions must be verified by more systematic functional analysis, including larger archaeological samples and ad hoc experimental studies.

General conclusion (B.V.)

How can we interpret the technological contrasts between Early and Final Natufian lunates considering that their use as insets for projectile weapons did not significantly change?

At first sight, it seems that Early Natufian lunate technology could fit well with certain characteristics of a “maintainable” system sensu Bleed (1986, 2002). It is obvious that Helwan lunates could have been manufactured very easily, even in short notice since the whole process could be performed with a single retouching tool (Fig. 17). Moreover, there is no need for a special firm support more sophisticated than a simple flat piece of wood or stone that is adequate to produce the
proximal microburin fracturation visible on some lunates. Nevertheless, it remains unclear whether this ease of manufacture is related to a similar simplicity in the hafting system: the constant need for thin hafted edges could correspond to high constraints in terms of fastening modes.

In contrast, the specific care paid to lunate manufacture during the Final Natufian seems to fit more clearly with the particular demands of a "reliable" system sensu Bleed (1986; 2002). The toolmakers certainly had good reasons for the transformations in method, role of retouching tools, and possibly even working positions observed (considering that a specific firm support was necessary for the roughing-out sequence Fig. 28A). It is tempting to conclude that some transformation of the hafting system occurred, considering the fact that acute retouched edges were transformed into rather thick ones, i.e., bevelled edges into flat surfaces. Moreover, a search for extreme miniaturization, which is a general trend in the entire region dominated by Natufian technology (Valla, 1984; Goring-Morris, 1987, Belfer-Cohen and Goring-Morris, 2002), seems to explain most of the difficult technical choices recognized in the Final Natufian at Eynan. What drove this need for miniaturization, in spite of debitage methods that did not follow a similar line of adaptation? The answer is probably to be found through a close examination of the Late Natufian, which corresponds to the beginning of this drastic decrease in geometric microlith size (Fig. 32). But for the time being, this answer is beyond our knowledge since it requires new research that will take into account the evolution of the lethal effectiveness of microliths through Natufian times. This effectiveness depends on many factors, including the propelng system, prey size, body part targeted, and main angles of penetration (in relation with the hunter’s position to the game), while the intensity of tissue damage and bleeding required depends on whether or not poison was used (for a broad perspective of these parameters and other variables see Knecht (ed.), 1997). At present, the available faunal data are too coarse relative to the precision required for such comparative studies. Nevertheless, archaeozoological data could be used as basis for developing an experimental research program aimed at understanding the practical advantages of tiny microliths.

The need for such a program is related to more general debates concerning microlithization. Due to very variable situations, the global tendency toward microlithization in Eurasia during the late Pleistocene and the Early Holocene
remains difficult to explain (Kuhn and Elston, 2002; Torrence, 2002). In this general trend, hypermicrolithization, as observed in the Final Natufian or French Mesolithic context, reveals a historical contingency whose mechanisms are probably easier to analyze in depth. Considering this general background, we are perfectly aware of the limitations of this study. It has nonetheless underlined the need for broader research involving larger samples from Eynan, including the Late Natufian levels. The Eynan assemblages must also be compared in a broader context with contemporaneous assemblages in order to depict the various mental images that could explain the main typological contrasts already described in the past for this specific period.

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NOTES

1. Some microliths were transformed to such an extent that it is impossible to confirm whether the earliest visible series corresponds to the initial one. On these microliths, the number of series observed (from two to four) is therefore a minimum.

2. However, this point of view does not deny the complexity of the problem. J. Pellegin noted that some of these microliths with alternating retouch (three out of the eight complete), identical to the others in their strictly morphometrical characteristics, exhibit scars that are more abrupt (± 70°) (Fig. 5:12, 14) than the ones observed on Helwan *stricto sensu* (± 50°) microliths. This difference in angle combined with other characters could indicate a different technique, i.e., exclusive use of soft stone instead of pressure (see below “Retouching techniques”), but this hypothesis is only highly probable. What is more clear is that the low obliquity obtained at this stage created a situation in which Helwan retouch *stricto sensu* (i.e., bifacial) was very difficult to realize, even if it could have been useful in order to correctly achieve the definitive shape of these microliths. Does this correspond to a circumstantial— and perhaps accidental—situation, or does it indicate the discrete presence of another method in our small sample? The question will remain unresolved until we can analyze a larger assemblage. Whatever the final interpretation, this technical component is clearly a minority.

3. “At least” means that this estimation is certain for only 17 microliths on which the earliest visible series corresponds to the initial one (Table 5). In addition, there are 10 other microliths on which it is not sure that the earliest visible series correspond to the initial one and which bear a minimum of two series (Table 6): some of them could therefore have registered only two series and not more, but it is not certain.

4. “At most” means that this estimation concerns all the microliths except the 17 on which the earliest visible series certainly corresponds to the initial one and which bear two series and not more (Table 5). As mentioned in note 3, 10 lunates among these 28 remaining ones (Table 6) bear a minimum of two series: some of them could therefore have registered only two series and not more, but it is not certain.

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**Appendix 1**

Early Natufian: 17 complete lunates on which the earliest visible series certainly corresponds to the initial one. Position and distribution of retouch for each series. Microliths were divided into six equal portions numbered “a-b-c-c-b-a” (Fig. 12): letters correspond to portions retouched; “X” corresponds to untouched portions. Underlined types indicate a lunate with discrete impact damage; italic types indicate a lunate abandoned during retouching process.

<table>
<thead>
<tr>
<th>Initial series</th>
<th>Series 2</th>
<th>Series 3</th>
<th>Series 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bifacial oblique partial</td>
<td>Direct on 6/6 of the edge abcba</td>
<td>Inverse on 4/6 of the edge XbcbaX</td>
<td>XbcbaX</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
<td>Direct on 6/6 abcba</td>
<td>Inverse on 2/6 aXXXXa</td>
<td>aXXXXa</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
<td>Direct on 6/6 abcba</td>
<td>Inverse on 2/6 XXcXa</td>
<td>XXcXa</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
<td>Direct on 5/6 abcXba</td>
<td>Inverse on 4/6 XbcXa</td>
<td>XbcXa</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
<td>Direct on 4/6 abXXba</td>
<td>Inverse on 6/6 abcba</td>
<td>abcba</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
<td>Direct</td>
<td>Inverse on 6/6 Distribution N.D abcba</td>
<td>abcba</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
<td>Inverse</td>
<td>Direct on 4/6 Distribution N.D aXXcX</td>
<td>aXXcX</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
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<td>Inverse on 2/6 XXXba</td>
<td>XXXba</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
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<td>Inverse on 5/6 Distribution N.D abXXba</td>
<td>abXXba</td>
</tr>
<tr>
<td>Bifacial oblique partial</td>
<td>Direct</td>
<td>Inverse on 2/6 Distribution N.D aXXcXX</td>
<td>aXXcXX</td>
</tr>
<tr>
<td>Alternate</td>
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<td>Inverse on 4/6 Distribution N.D abXXba</td>
<td>abXXba</td>
</tr>
<tr>
<td>Alternate</td>
<td>Direct</td>
<td>Inverse on 3/6 Distribution N.D abcXXX</td>
<td>abcXXX</td>
</tr>
<tr>
<td>Alternate</td>
<td>Direct</td>
<td>Inverse on 2/6 Distribution N.D XXXXba</td>
<td>XXXXba</td>
</tr>
<tr>
<td>Alternate</td>
<td>Direct</td>
<td>Inverse on 2/6 Distribution N.D XXcXX</td>
<td>XXcXX</td>
</tr>
<tr>
<td>Alternate</td>
<td>Direct</td>
<td>Inverse on 1/6 Distribution N.D XXXXba</td>
<td>XXXXba</td>
</tr>
<tr>
<td>Alternate</td>
<td>Direct</td>
<td>Inverse on 4/6 Distribution N.D abXXba</td>
<td>abXXba</td>
</tr>
<tr>
<td>Alternate</td>
<td>Direct</td>
<td>Inverse on 2/6 Distribution N.D abXXba</td>
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<tr>
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<td>Inverse on 1/6 Distribution N.D XXXXba</td>
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<tr>
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<td>Direct</td>
<td>Inverse on 1/6 Distribution N.D XXXXba</td>
<td>XXXXba</td>
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</table>
Appendix 2

Early Netufian: 13 complete lunates on which it is not sure that the earliest visible series correspond to the initial one. Position and distribution of retouch for each series. Microliths were divided into six equal portions numbered “a-b-c-c-b-a” (Fig. 12): letters correspond to portions retouched; “X” corresponds to unretouched portions. Italic types indicate a lunate abandoned during retouching process.

<table>
<thead>
<tr>
<th>Bifacial oblique total</th>
<th>1st visible series</th>
<th>2nd visible series</th>
<th>3rd visible series</th>
<th>4th visible series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct on 6/6 of the edge abcba</td>
<td>Inverse on 6/6 of the edge abcba</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse on 6/6 abcba</td>
<td>Direct on 6/6 abcba</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse on 6/6 abcba</td>
<td>Direct on 4/6 abcXXa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse on 6/6 abcba</td>
<td>Direct on 4/6 abcXhX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse on 6/6 abcba</td>
<td>Direct on 6/6 abcba</td>
<td>Inverse on 1/6 XbXXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse on 5/6 Xbecba</td>
<td>Direct on 5/6 abXeba</td>
<td>Inverse on 1/6 XXXXbX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse on 5/6 abcbX</td>
<td>Direct on 5/6 abcbX</td>
<td>Inverse on 1/6 XXXeXX</td>
<td>Direct on 2/6 XXXXba</td>
<td></td>
</tr>
<tr>
<td>Direct Distribution N.D. abcba</td>
<td>Inverse on 6/6 abcba</td>
<td>Direct on 2/6 XXXXbX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse Distribution N.D. abcba</td>
<td>Direct on 6/6 XXXcXX</td>
<td>Inverse on 1/6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse Distribution N.D. abcba</td>
<td>Direct on 5/6 abcXX</td>
<td>Inverse on 6/6 abcba</td>
<td>abcba</td>
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<td>Inverse Distribution N.D. XXXXXba</td>
<td>Direct on 2/6 XXXXba</td>
<td>Inverse on 1/6 XXXXbX</td>
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<tr>
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<td>Direct on 6/6 abcba</td>
<td>Inverse on 3/6 XbcXXa</td>
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<tr>
<td>Direct Distribution N.D. XXXX2a</td>
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<td></td>
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