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Make my axe: flint axe production and resharpening at EPPNB Nahal Lavan 109

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Introduction

The site of Nahal Lavan 109 (henceforth NL109) is located in the Central Negev, Israel, on a loess slope at the southern bank of Nahal Lavan, some 243 m above sea level. This is an arid area with annual precipitation of less than 100 mm. The vegetation in the area is relatively rich, including some trees in the wadi systems. During rainy years annual vegetation such as oats and barley appears as well.

The site was discovered and sampled in 1973 by E. Friedman and F. Burian, who estimated its size in some 3500 sq. m. 900 sq. m. were systematically collected using a grid system of 2X2 m. (Burian, Friedman and Mintz 1976). Forty-seven collection units of 2X2 m were excavated to a depth of maximum ten centimeters, the sediments were sieved and all finds collected. The finds from the rest of the grid units were collected without sieving and such was also the case for finds from the rest of the site. No architectural features or installations were observed, although the abundance of small cracked stones could indicate the presence of hearths.

Among the finds, flint items are the most frequent. Some 400 obsidian items were collected as well, in addition to bones, beads made of ostrich eggshell, groundstone tools and a stone figurine.

Burian and Friedman assigned NL 109 to an early phase of the PPNB according to typological characteristics of the lithic assemblage (Burian, Friedman and Mintz 1976). Gopher, on the basis of seriation analysis, assigned the site to an early part of the second half of the eighth Millenium BP (Gopher 1994: 232-3) and later, on typological and technological grounds of the flint industry, included the site in the EPPNB (Gopher 1996).

The study presented in this paper deals with bifacial tools and spalls found at NL 109. A detailed technological and typological analysis is used for characterizing the bifacial tool category and for understanding the site's function.

The Flint Assemblage

For the analysis presented in this paper the bifacial tool category was re-studied by the author. The assemblage available until 1976 was processed by E. Mintz while items collected after 1976 were never studied. We intend to present a complete analysis of the flint assemblage from NL 109 in the future.

According to the analysis carried out by Mintz at 1976, the tool assemblage included 1600 items, almost half of which were classified as arrowheads (47%, n= 774). Further collections in the late 1970s and early 1980s enlarged the sample and Gopher was able to study 1380 arrowheads in 1985. The updated relative frequencies of arrowheads are not known at the moment, but it may be assumed that they still comprise about half of the tool assemblage. The 1380 arrowheads analyzed by Gopher (1994: 155-159) revealed a clear dominance of Helwan points (over 80%) in this tool category, 18% Jericho points, a few Byblos points and two El Khiam points. Gopher notes that some of the Jericho points could be, in fact, Helwan points in different stages of shaping (Gopher 1994:158), thus enlarging the dominance of Helwan points in the assemblage. In addition to the arrowheads classified by Gopher,

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Burian and Friedman described 300 artifacts as Helwan points in preparation. As noted by Gopher (1994:158-9), dominance of Helwan points is a rare phenomenon in the Levant. A high degree of homogeneity was noted among the arrowheads and it was therefor suggested that a small group of people or even a single craftsman produced these arrowheads. The large quantity of Helwan points and the presence of arrowheads in different stages of manufacture led Burian and Friedman to the conclusion that NL 109 was actually a workshop for arrowheads production (Burian, Friedman and Mintz 1976).

It is interesting that sickle blades appear too, including Beit Ta`amir knives, typical of the PPNA sultanian, and characteristic finely denticulated sickle blades. Drills, retouched items and a large number of burins also appear.

253 bifacial tools, as well as 20 transverse spalls of axes, were available for this study.

Flint bifacial tools from NL 109

The 253 bifacial tools were subjected to a detailed attribute analysis, including both qualitative and quantitative observations and measurements. The relevant results of the analysis are presented in order to provide data for discussion and interpretation.

Bifacial tool types - the 253 bifacial tools in this assemblage were divided into five major categories according to the following definitions (fig 1):

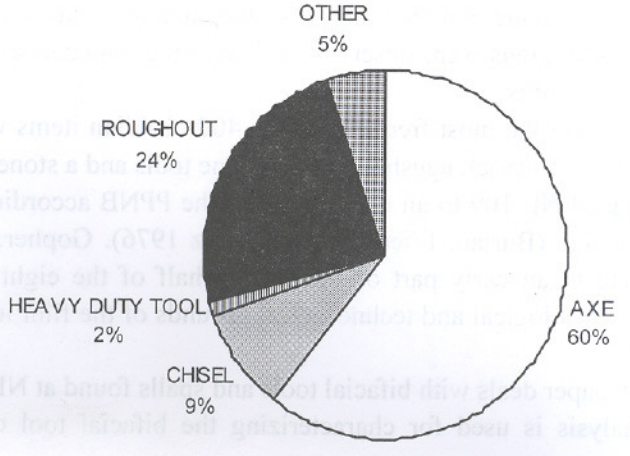

Fig. 1: Bifacial tool types (n= 253)

Axe (n= 151, Fig. 3; 4;5:1,2; 6:2) - shaped by bifacial flaking, lenticular cross section, cutting edge shaped by transverse blow or bifacial flaking and wider than 2 cm. In order to determine the metrical and morphological differences between axes and chisels, length:cutting edge width relations are presented below, as well as the relation between cutting edge width and the central thickness of axes and chisels.

Roughout (preform, n= 60, Fig. 2; 5:3) - rough and coarse bifacial tools, most often only partially worked by bifacial flaking. The cutting edge is either shaped or not.

Chisel (n= 23, Fig 6:1) - shaped by bifacial flaking, lenticular or angular cross section, usually long and narrow with a cutting edge not exceeding 2 cm. in width.

Other (n= 13) - broken and unclasifiable bifacial tools.

Heavy duty tools (n= 6) - large, heavy and coarse bifacial tools. In some cases these could represent roughouts in very early stages of manufacture.

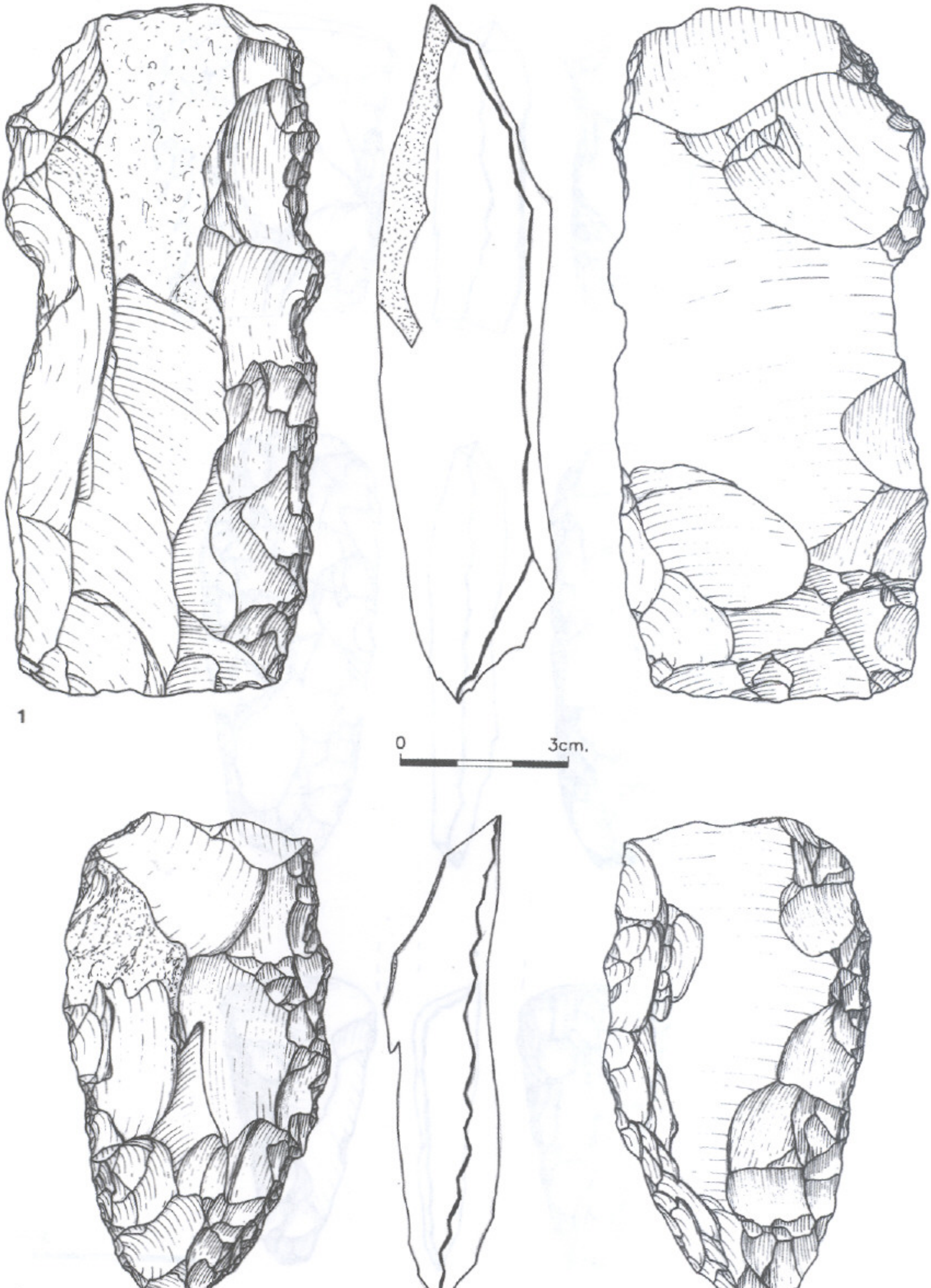

Fig. 2: Axe roughouts from NL 109.

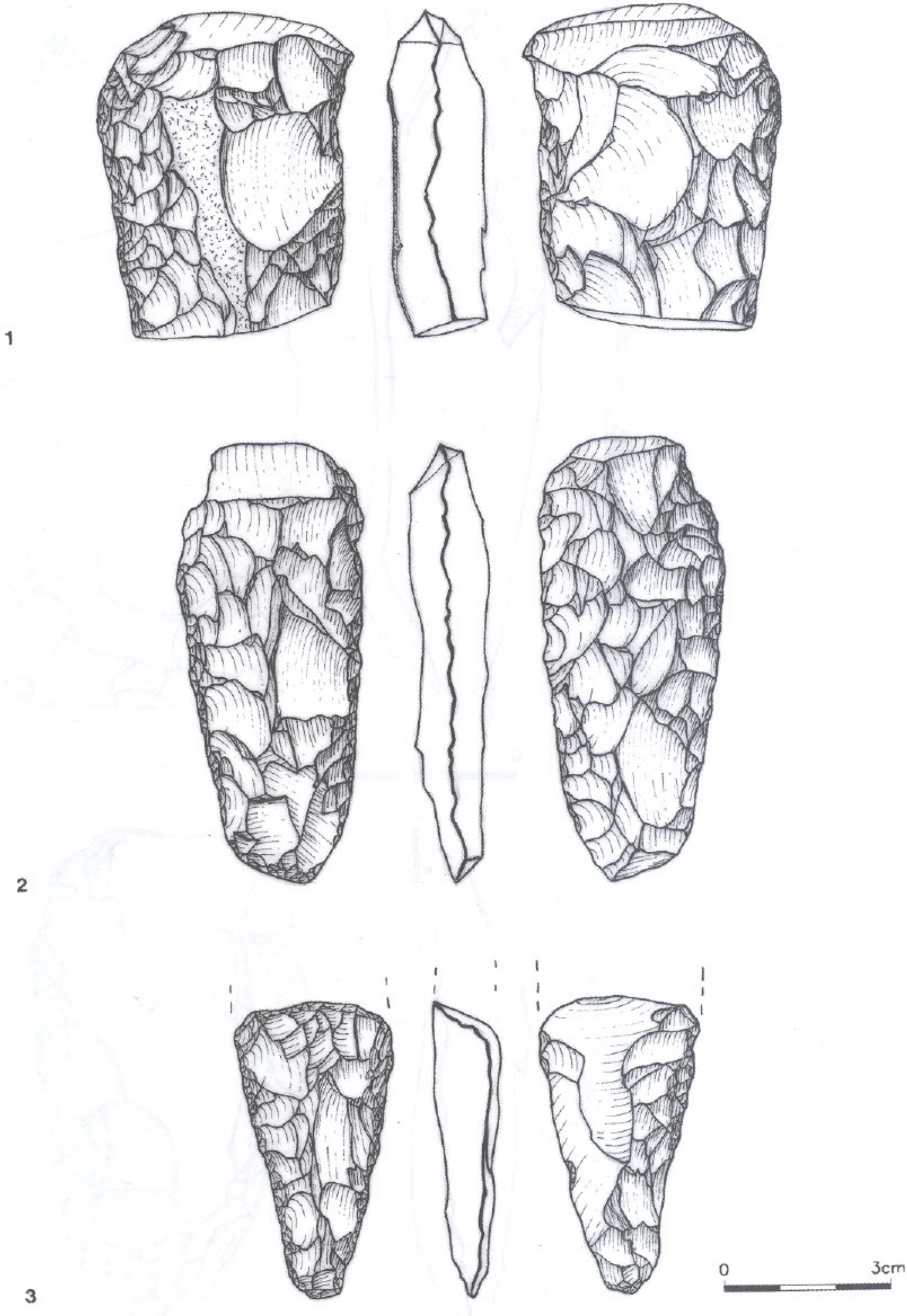

Fig. 3: Axe and axe fragments from NL 109.

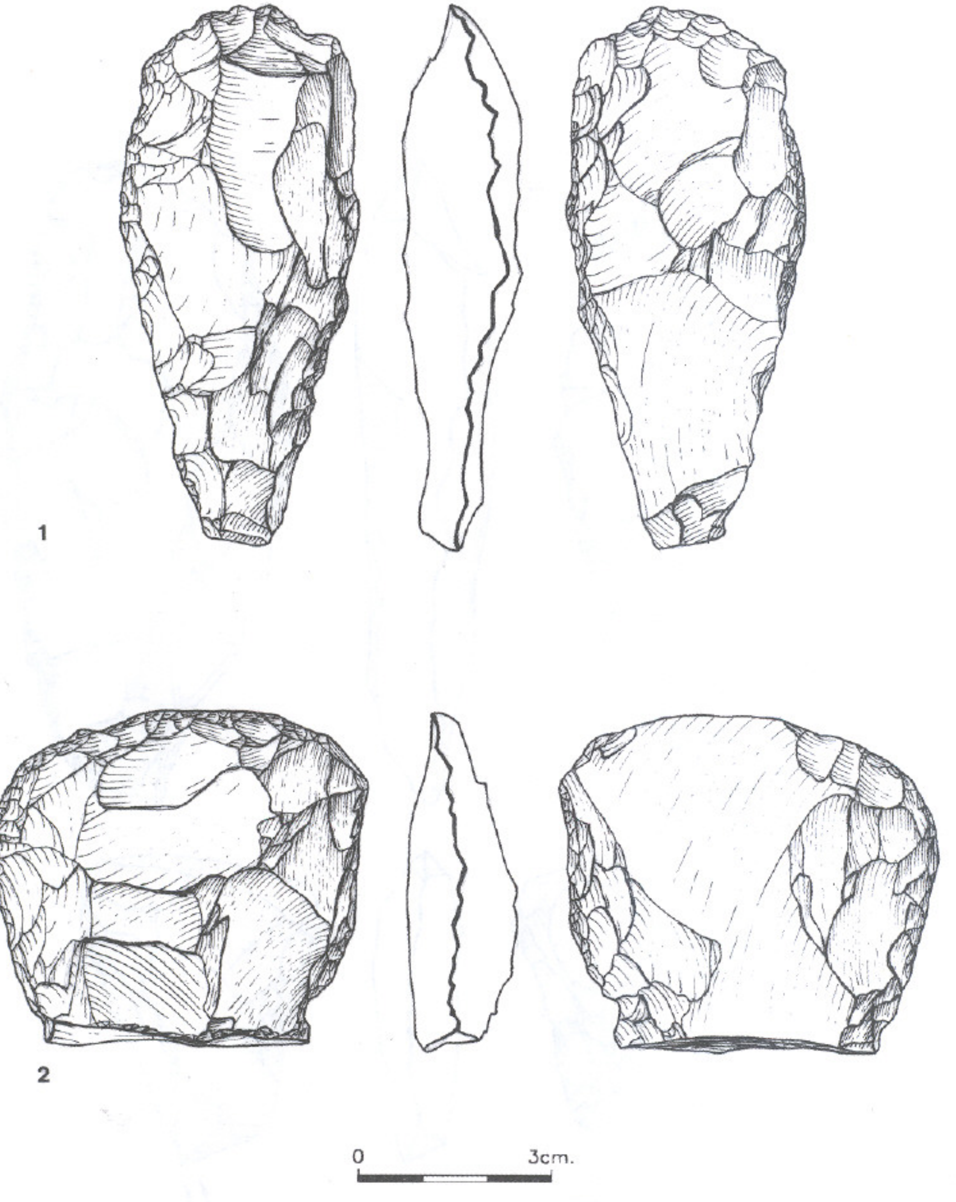

Fig. 4: Axe and axe fragment from NL 109.

The bifacial tool category of NL 109 is clearly dominated by axes and axe roughouts. Most of the roughouts resemble the axes both in technological and morphological terms while only a few could be described as chisel roughouts due to their cutting edge width and shape.

The axes and chisels were shaped using the same techniques and thus are closely related. As will be demonstrated later, some of the chisels were even shaped by transverse blows. In this assemblage the most striking difference between axes and chisels is morphological. The axes are usually triangular in shape while the chisels are oval and narrow (see below).

Raw material quality of bifacial tools (Fig. 7) - Most of the axes (74%) and more than half of the roughouts (55%) and chisels (52%) are made of high quality, superior, siliceous flint with no inclusions. Another 16% of the axes, 37% of the roughouts and 31% of the chisels were made of high quality flint with minor inclusions. In total, the great majority of axes (90%), roughout (92%) and chisels (83%) were made of high quality raw material. This pattern of raw material selection for bifacial

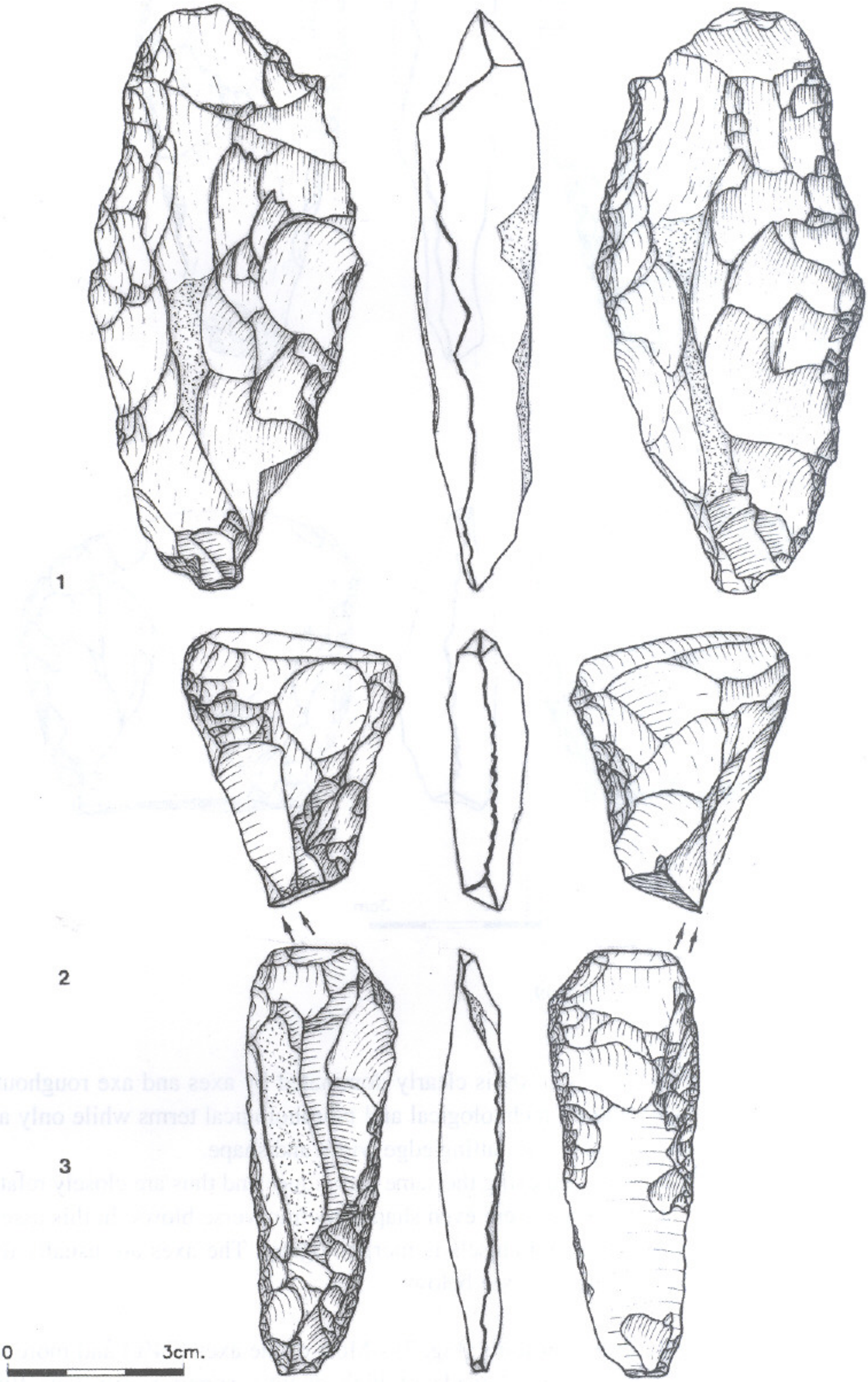

Fig. 5: Axes and chisel from NL 109.

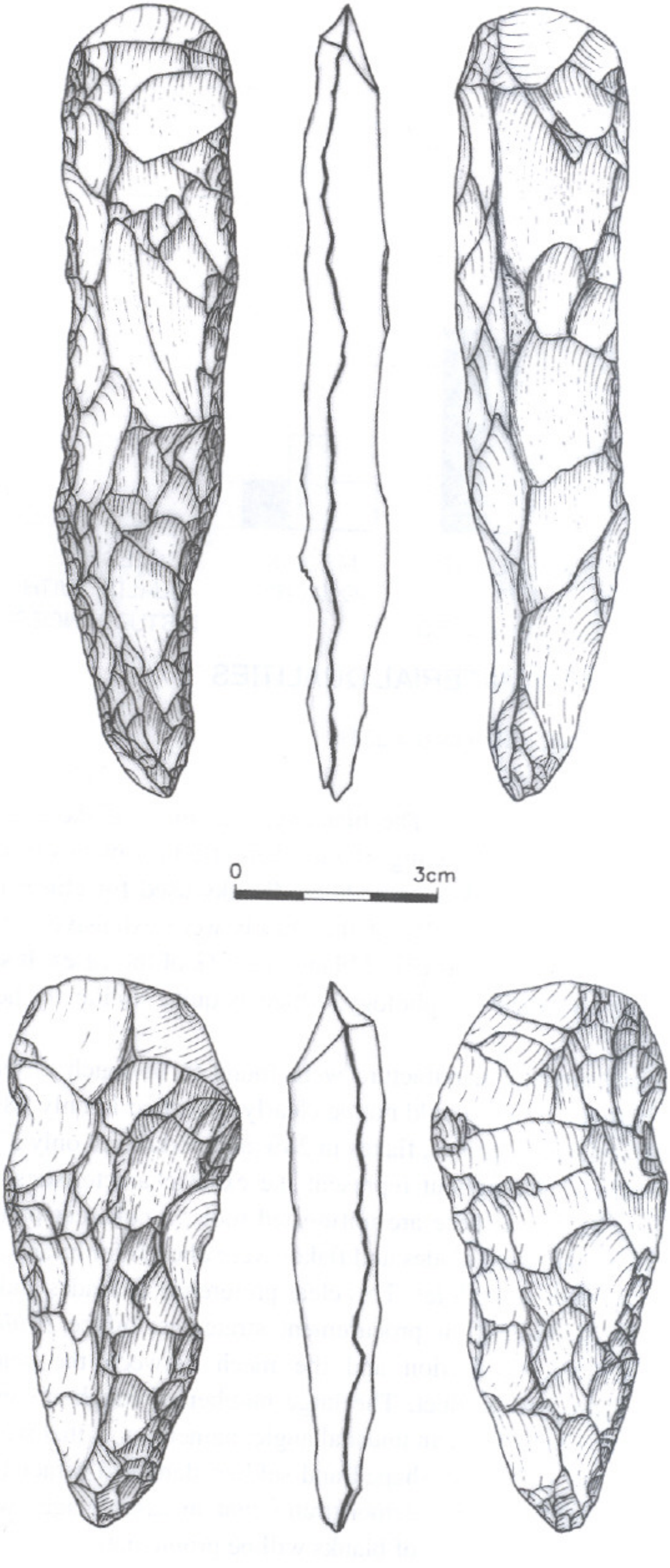

Fig. 6: Chisel and axe from NL 109.

manufacture is extraordinary in view of both Natufian and later Neolithic lithic industries, which preferred coarser and rougher raw material for bifacial tool production.

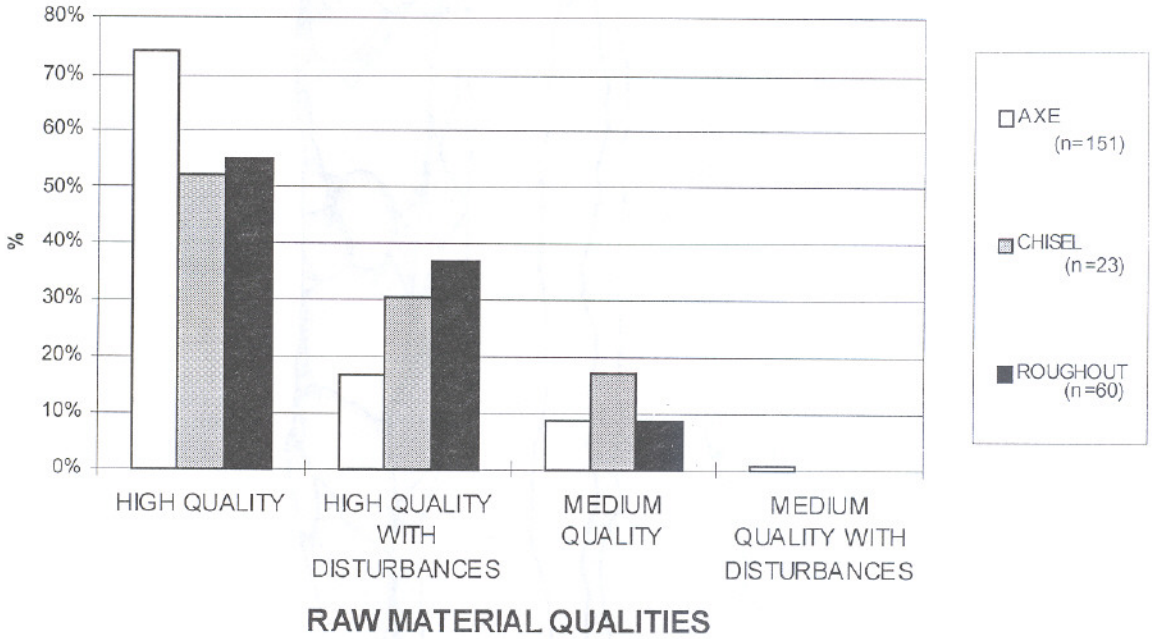

Fig. 7: Raw material qualities of bifacial tools (n= 234).

Blanks of bifacial tools (Fig. 8) - The blank type of most of the axes (79%) could not be determined because of extensive bifacial flaking. Blades were used for blanks in 17% of the axes, while only few axes were clearly made of flakes or nodules. Blanks used for chisel production were quite different from those used for axes. Only 52% of the chisels were extensively worked and the blanks could not be classified. Blades were used as chisel blanks in 43% of the cases. It seems that blades were preferred as chisel blanks due to their morphology, which is quite similar to the desired shape of the tool.

Blanks selected for roughout manufacture were found to be much different than those of the completely shaped bifacial tools. Blanks could not be clearly classified in only 28% of the cases. Blades were used as blanks in 40% of the roughouts, flakes in 28% and nodules in only 3% of the preforms.

I would like to argue that roughout represent the exact characteristics of blanks selected for biface production (e.g. Fig. 2). Since these are unfinished tools, a coherent pattern of blank selection could be suggested. In 70% of the cases blades and flakes were chosen for biface production. Only small number of bifacial tools was made of nodules. This clear preference of blades and flakes over nodules is important in terms of understanding flint procurement strategies, biface *chaîne Opératoire*, blanks transport, the location of blank production and the mach between the selected blanks and the morphology and metrics of the end product. The large number of roughouts enables us to study the production sequence of bifacial tools from an unusual angle, namely tools that were discarded during the process of manufacture and not only fully shaped and seldom damaged bifacial tools. The analysis of bifacial tools blanks from NL 109 clearly demonstrates that in assemblages which does not include roughouts of bifacial tools, the identification of blanks will be problematic.

Cutting edge shaping of bifacial tools (Fig. 9) - Single or double transverse (tranchet) blows is the most common strategy for creating the working edges of axes (85%, Fig. 3:1,2; 5:1,2; 6:2). Most of the cutting edges of roughouts are shaped by bifacial or unifacial flaking (76%), while the cutting edges of additional 17% are not shaped at all (Fig. 2). Only few roughouts (8%) have a cutting edge shaped by

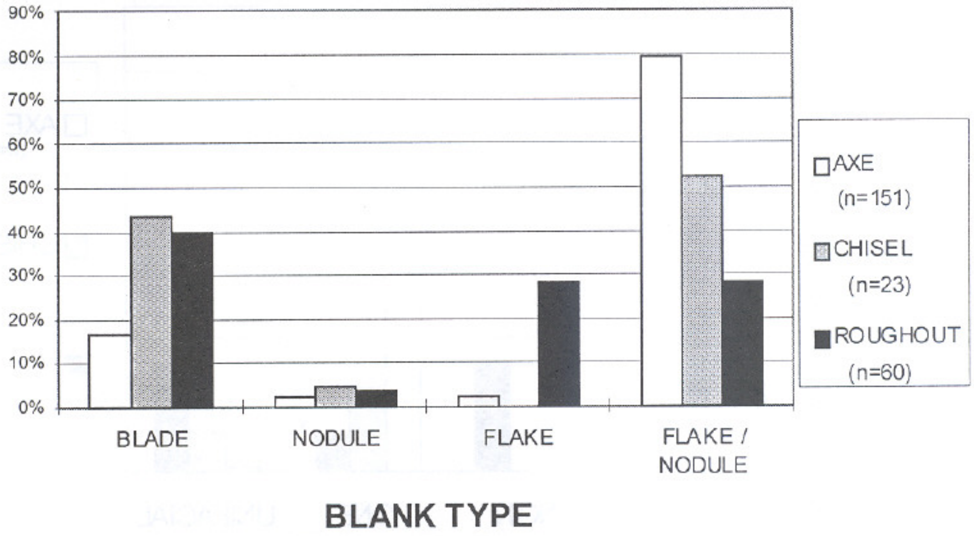

Fig. 8: Blanks of bifacial tools (n= 234).

transverse blows. Cutting edges of chisels are almost evenly divided between single or double transverse blows (51%, Fig. 6:1) and bifacial flaking (43%).

Since the cutting edges of most of the shaped axes are shaped by transverse blows, and since most of the roughouts are not shaped by transverse blows, it could be argued that the working edge of axes was shaped in the later stages of the production sequence, after the tool was successfully shaped by bifacial flaking.

It should be mentioned that 55% of the cutting edges of axes were shaped by two intersecting transverse blows, while other 30% of the axes were shaped by a single tranchet blow on one face and bifacial flaking or flat, flaked, surface on the other face.

Body shaping of bifacial tools (Fig.10) - Most of the axes (80%) and chisels (73%) were shaped by overall bifacial flaking, as opposed to only 20% of the roughouts. Partial bifacial flaking, on the other hand, shapes most of the roughouts (80%), as opposed to much lower numbers of axes and chisels (20% and 26% respectively).

These results emphasis the differences between completely shaped bifacial tools and roughouts or preforms. It seems that the most common strategy for axe production was overall bifacial flaking on both faces, thus the partial bifacial flaking on roughouts must represent an interruption in the production sequence.

Shape of bifacial tools – Half of the axes (51%) and roughouts (48%) are triangular in shape (Fig. 3:3; 6:2), having a wide cutting edge and a pointed base. Another quarter of the axes (27%) and roughouts (27%) are long and relatively narrow, with straight bases and minor differences in width between the working edge and the base (Fig. 3:2). Additional 13% of the axes and 10% of the roughouts are trapezoidal in shape, having a wide cutting edge and a straight base. As was demonstrated above, a very close resemblance was found between the shapes of axes and roughouts. The only clear difference is the presence of round or rectangular roughouts (10%) as opposed to only few round axes (1%). I believe that the similarities in shape between axes and roughouts indicate that these roughouts reached an advanced stage in the manufacturing process. It could be suggested that the standard shape of axes was triangular or trapezoidal (64%), including an additional group of elongated trapezes (27%) of blade dimensions.

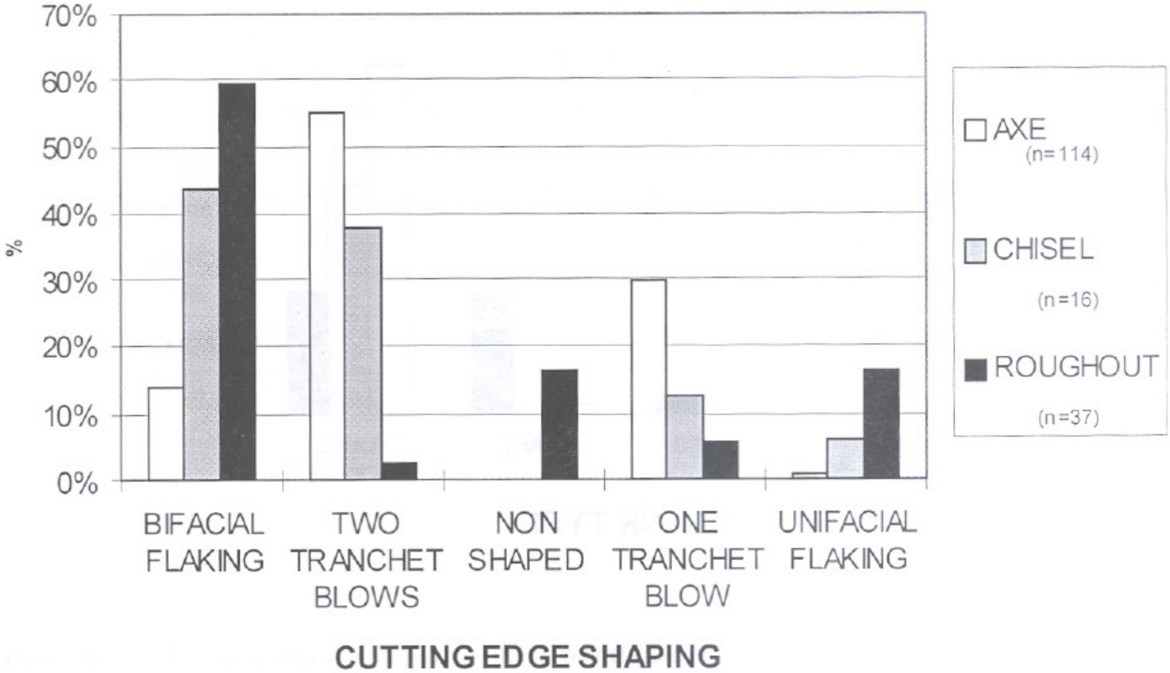

Fig. 9: Cutting edge shaping of bifacial tools (n=167)

Chisels differ in shape from the rest of the bifacial tools. A striking majority of the chisels (65%) are long and narrow, with a pointed or curved cutting edge, sometimes rhomboid in shape (Fig. 6:1). Another 35% of the chisels are in the shape of a long trapeze, resembling in shape to some of the axes but with a cutting edge not exceeding 2 cm. in width.

Cross and length section of bifacial tools: Most of the axes (82%) are lenticular (convex - convex) in section (Fig. 3:1,2; 5:1,2; 6:2) while smaller numbers (13%) have a combination of lenticular and plano – convex sections (Fig. 3:3). Roughouts cross and length sections are evenly divided between lenticular (42%) and combined (lenticular and plano - convex, 40%) sections. Since the preferable strategy of axe production was aimed at creating lenticular sections, it seems reasonable to assume that some of the roughouts were discarded before the final shaping of cross and length sections.

Half of the chisels have lenticular sections, while the rest are divided between combined and angular sections.

State of preservation of bifacial tools (Fig. 11) - The majority of axes, roughouts and chisels were found complete (63%, 64% and 56% respectively). The lower half of the tool represents the most common broken bifacials (base and medial parts, 21% of the axes, 33% of roughouts and 26% of chisels, Fig. 3:3). Medial parts are almost completely absent (only 1% of the axes and 2% of the roughouts). Upper halves of broken bifacial tools are represented by 16% of the axes and 17% of the chisels, and only by 2% of the roughouts (Fig. 1, 4:2). While there is a close similarity between the percentages of broken lower and upper halves of axes and chisels, upper halves of roughouts are extremely rare as opposed to many lower halves.

Discard patterns of complete bifacial tools (Fig. 12) - Since large percentages of bifacial tools are complete, and assuming that breakage was the reason for discarding the rest of the bifacial tools, it seems essential to check what were the main reasons of complete bifacial discard.

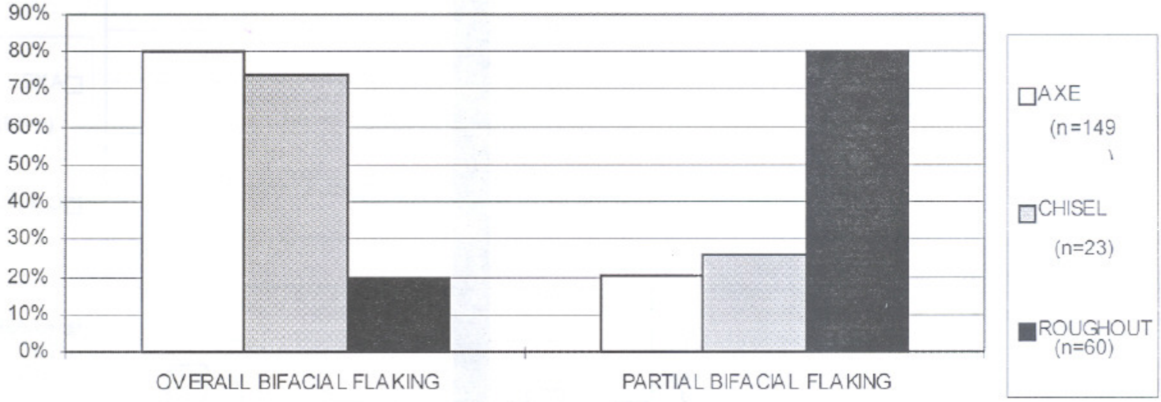

Fig. 10: Body shaping of bifacial tools (n= 232).

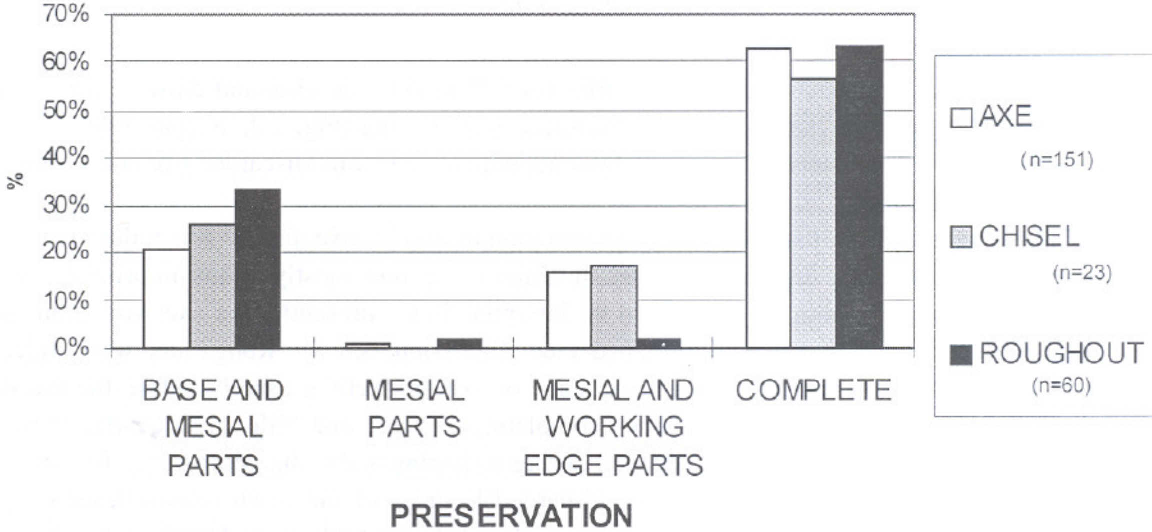

Fig. 11: State of preservation of bifacial tools (n= 234).

Most of the axes (60%) were discarded because of unsuccessful repair, failing to repair the axe by transverse blows and/or by bifacial blows (Fig. 3:2; 4:1; 5:1; 6:2). In all cases it is clear that shaped axes were reshaped or resharpened by correcting transverse and/or bifacial blows, but these attempts failed because of hinge or step fractures, overshots, blunt cutting edge or other knapping errors. Another 13% of the axes were discarded because of unsuccessful repair and cutting edge damage (unintentional flaking, battering and minor fractures). Unsuccessful shaping was the cause of discard of 11% of the axes, mainly failing attempts to shape the cutting edge by primary transverse blow or failing bifacial blows that were intended to shape the bifacial tool (these are in fact border cases between roughouts and axes). Cutting edge damage was the sole cause of discard of 6% of the axes and only 7% of the axes were discarded because of unknown reason.The discard pattern of chisels is quite similar to the axes, except for higher percentage of chisels that were discarded for unknown reason (31%, Fig. 6:1) and lower percentages of chisels discarded because of unsuccessful repair.

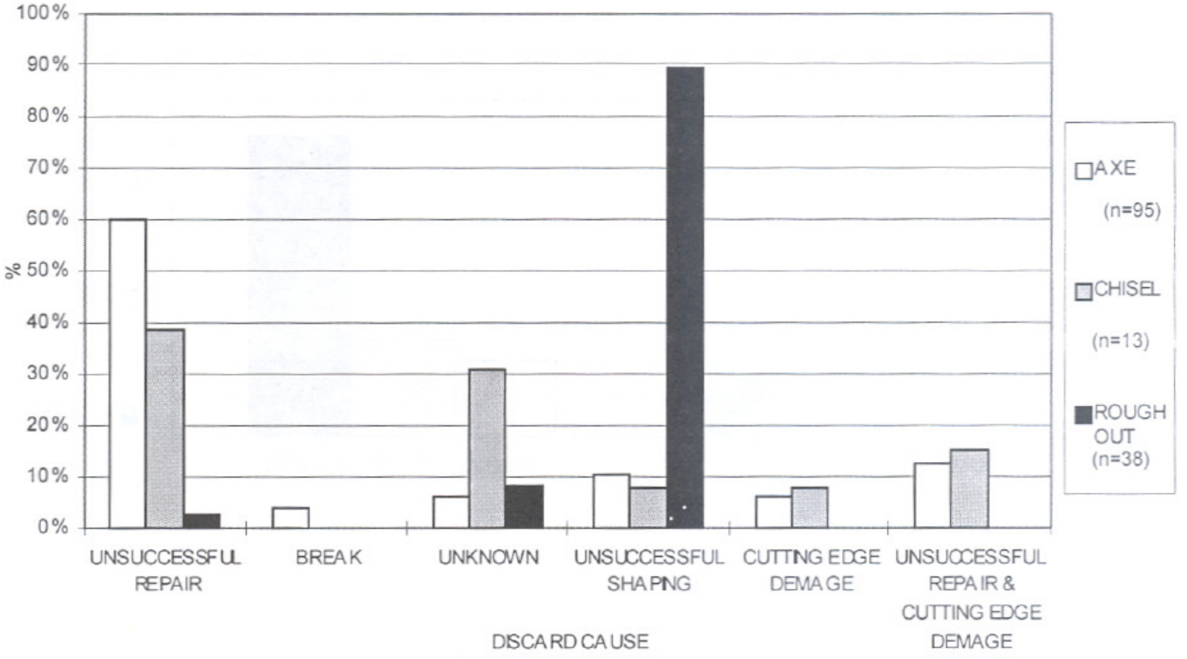

Fig. 12: Discard patterns of complete bifacial tools (n=146).

Roughouts have a specific discard pattern, much different than axes and chisels. Almost all of the roughouts, 89%, were discarded because of unsuccessful shaping (Fig. 2:2, as opposed to only 11% of the axes and 8% of the chisels). The rest of the roughouts were mainly discarded because of unknown reasons (Fig. 2:1,8%).

These results indicate that while the most common reason for axe discard was failure in repair or resharpening, roughouts were discarded because of different reasons, mostly failure in primary shaping. I would like to argue that these results should be interpreted as representing an axe workshop, where axes were produced, resharpened and reshaped (see discussion below). Roughouts were didcarded because of unsuccessful bifacial blows, in some stage of axe production, usually before the transverse blow was applied. Axes were discarded after completing at least one "life cycle", after they were manufactured, probably used, and then discarded during reshaping and resharpening (e.g. Fig. 5:1; 6:2). The low numbers of bifacial tools that were discarded because of unknown reason deserve special attention. Only very few useful, undamaged or unbroken bifacial tools were found at NL 109. This situation is most likely typical to a specialized workshop site, where tools are produced, maintained and then taken away.

Repair methods of axes that were discarded because of unsuccessful repair (Fig. 13). - In more than half of the cases (54%) axes were reshaped and resharpened by correcting transverse blows and bifacial flaking (e.g. Fig. 6:2). The transverse blow was applied in order to reshape and resharpen the cutting edge, while bifacial flaking was used in order to reshape the whole tool and adjust the axe dimensions to the new cutting edge. As was argued before, some of these correction blows failed and thus the axe was discarded (e.g. Fig. 6:2).

Twenty five percent of these axes were discarded because of unsuccessful bifacial flaking of the cutting edge and the axe body, while another 21% were discarded because of unsuccessful bifacial flaking of the axe body only (e.g. Fig. 4:1).

These results indicate that the most common repair of axes was a combination of bifacial flaking on the axe faces and a tranchet blow on the cutting edge. These two techniques appear together because reshaping of the axe is necessary before executing the correcting transverse blow for preparing the axe new margins and creating a suitable striking platform. The rest of the axes were discarded because of

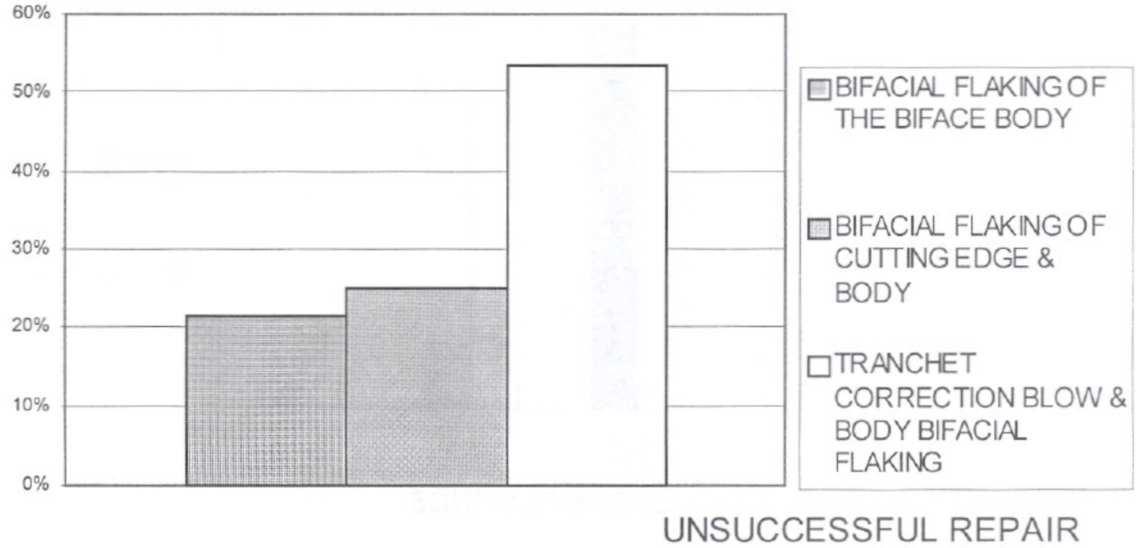

Fig. 13: Repair methods of axes that were discarded because of unsuccessful repair (n= 56).

unsuccessful bifacial flaking both on the axe faces and cutting edge. It could be suggested that these blows were intended to prepare the axe for applying the transverse blow. In these cases the preparation stage was not successful and therefor the repaired axe was discarded before the tranchet blow. The fact that most of the complete axes (85%) are shaped by transverse blows supports the argument that repairing the axe by bifacial flaking was intended for setting the platform for a transverse blow.

Number of bifacial cross flakings on complete bifacial tools (Fig. 14) - About 45% of both axes and roughouts bear scars of 5-6 bifacial cross flakings which traveled beyond the midline of the tool. But here the similarity ends while 38% of the axes have scars of 7-8 bifacial cross flakings, 38% of the roughouts have evidence of only 3-4 scars of that kind. The fact that almost half of the complete axes and roughouts have the same number of bifacial cross flakings reinforce the argument that many of the roughouts were discarded in a later stage of production.

Metrical data of bifacial tools - Length, width (cutting edge, mid part and base) and thickness (cutting edge, mid part and base) measurements were taken.

A detailed description is beyond the scope of this paper and therefore only general statements will be provided.

Length of complete bifacial tools: Most of the axes and roughouts (60%) are between 60-80 mm in length. The rest of the roughouts are usually slightly longer than the rest of the axes. Only a very small number of bifacial tools (2% of the axes and 3% of the roughouts) exceed 100 mm in length. The average length of complete axes is 68.1 mm (n= 95) and 69.2 mm for complete chisels (n= 13).

Width of cutting edges (Fig. 15): The width of the tips of most of the axes (70%) and roughouts (60%) ranges between 22-30 mm. Only 6% of the axes and 7% of the roughouts have a cutting edge of 20-21 nmm in width. Another 20% of the axes and 17% of the roughouts have a cutting edge width of 31-40 mm. The width of all cutting edges of chisels is less than 20 mm, with 36% of the chisels having a cutting edge narrower than 10 mm. The majority of axes falls in the range of 24-35 mm cutting edge width (65%) with a clear fall off around 20-21 mm. Thus, the dividing line between cutting edge width of axes and chisels is around 20 mm. Average cutting edge width is 26.4 mm for complete axes (n= 95) and 12.4 mm for complete chisels (n= 13). As was noted earlier, length/cutting edge relations are used in order to demonstrate the difference between complete axes and chisels. Length/

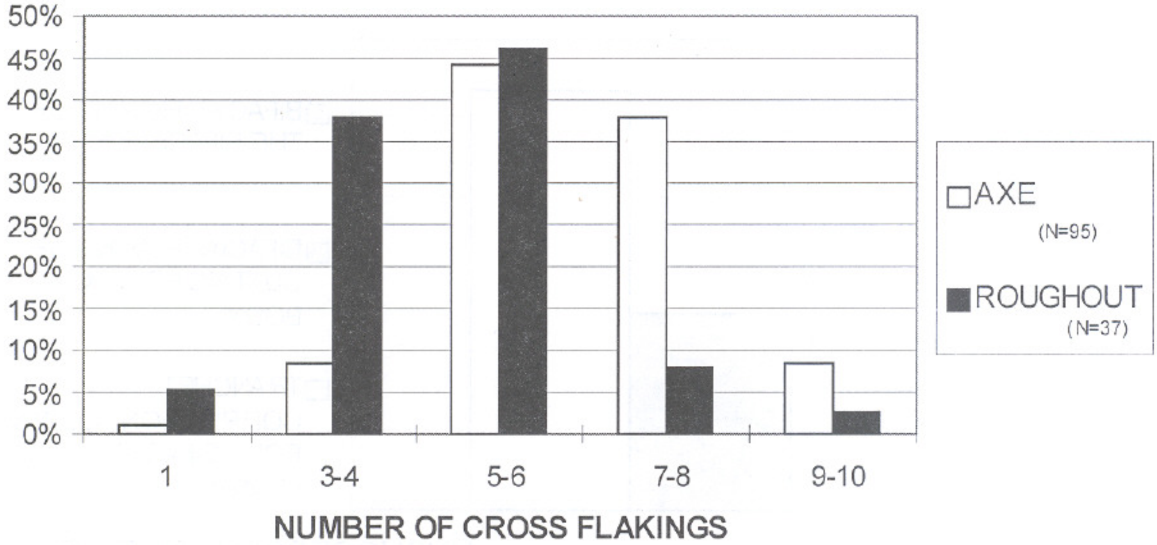

Fig. 14: Number of bifacial cross flakings of complete bifacial tools (n= 132).

cutting edge relations are 2.5:1 for complete axes as opposed of 5.5:1 for complete chisels. This is a pronounced difference, which emphasizes the morphological differences between these tool types. Thus the typological subdivision according to cutting edge width alone was found to be valid. In general terms, the bifacial tools from NL 109 have a relatively narrow cutting edge, which most probably represent relatively small axes.

Mid width: The mid width of most of the axes (75%) and roughouts (60%) ranges between 21-30 mm. Additional 17% of the axes and 28% of the roughouts are between 31-40 mm in mid width. The roughouts are generally slightly wider than the axes, but both of these types represents relatively narrow bifacial tools that were probably made of narrow blanks.

Base width (Fig. 16): Most of the axes (62%) are between 6-10 mm. wide at the base, as opposed to only 37% of the roughouts. Most of the roughouts (57%) have a base width larger than 10mm, as opposed to only 37% of the axes. As was shown previously, roughouts are slightly wider at the base than axes and thus represent unfinished tools.

Cutting edge thickness (Fig. 17): The thickness of the cutting edge was measured a few mm below the actual tip of the tool, in the line which connects the top ends of the tool margins. Cutting edge thickness of most of the axes (75%) ranges between 3-4 mm. as opposed to only 17% of the roughouts. Most of the roughouts (44%) have a cutting edge between 5-6 m. thick, as opposed to only 21% of the axes. The cutting edge of the rest of the roughouts (39%) is thicker than 7 mm. as opposed to only 4% of the axes. It could be stated that cutting edges of roughouts are generally thicker than those of shaped axes basically because this part of the roughout was not shaped yet since shaping the working edge is done only in the final part of axe production.

Mid thickness (Fig. 18): The majority of axes (84%) and roughouts (80%) are between 11-20 mm. thick in the middle of the tool. The rest of the roughouts are slightly thicker than the rest of the axes. The similarities in mid thickness between axes and roughouts is striking and might indicate that the mid thickness of the tool is achieved at the primary stages of axe production. In any case, the bifacial tools from NL 109 are relatively thin, most commonly not exceeding 20 mm. in thickness. This is a very distinctive characteristic of the bifacial tools from the site and it could indicate a very special production/selection of blanks. Mid thickness average of axes is 13.7 mm (n= 151), as opposed to 12.7

of chisels (n= 23). Cutting edge average of all axes and chisels is 27.4 mm and 13.1 mm respectively. Thus, cutting edge width:mid thickness relation of axes is 2:1 as opposed to 1:1 for chisels. While mid thickness average of axes and chisels is quite similar, the difference in cutting edge width is clear. These results seem to justify the conventional division of axes and chisels acording to cutting edge width.

Base thickness (Fig. 19): A third of the axes (31%) as opposed to only 15% of the roughouts are between 3-4 mm. thick at the base. Another half of the axes (51%) as opposed to 36% of the roughouts are 5-6 mm. thick at the base. The majority of the roughouts (49%) have a base thicker than 6 mm. as opposed to only 18% of the axes.

These results support the slight difference in thickness between axes and roughouts which is most pronounced at the base and tip. It seems likely that the mid thickness of the tool is modified during early stages of manufacture while the base and tip are shaped at the end of this process.

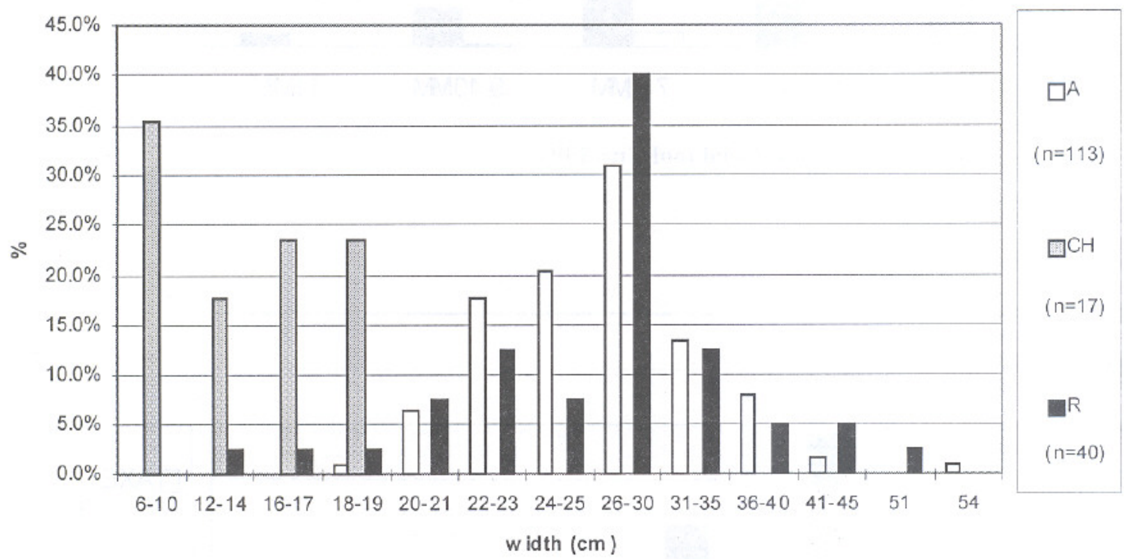

Fig. 15: Cutting edge width of bifacial tools (n= 170).

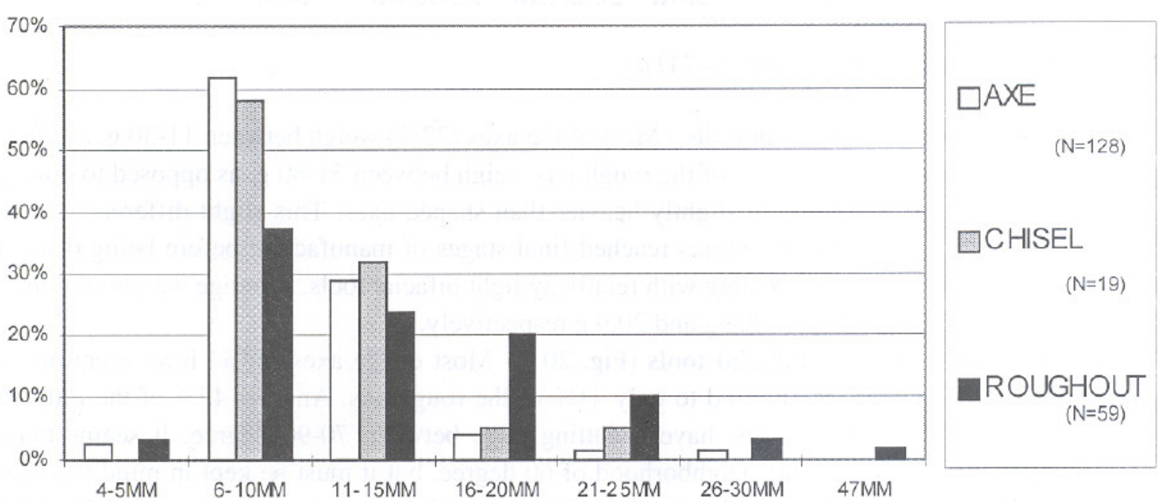

Fig. 16: Base width of bifacial tools (n= 206).

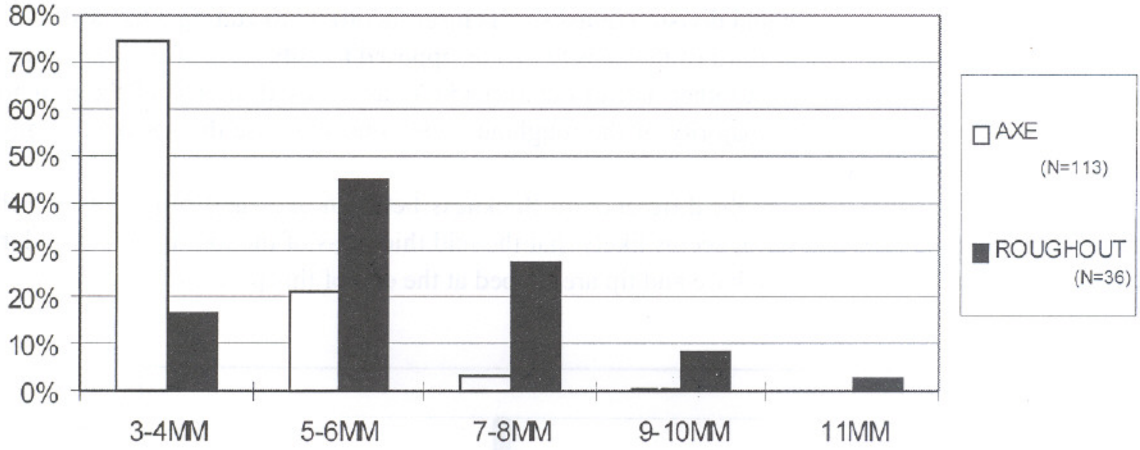

Fig. 17: Cutting edge thickness of bifacial tools (n= 149).

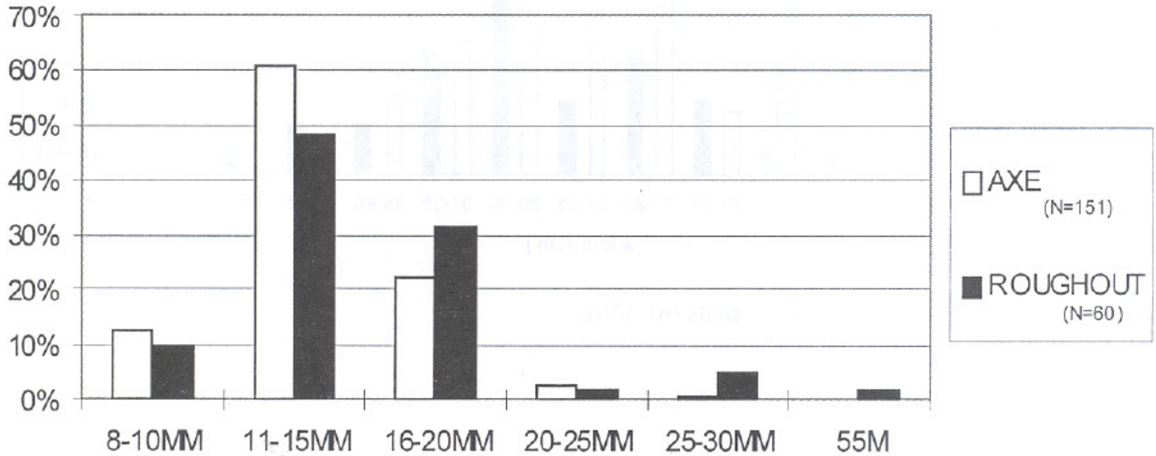

Fig. 18: Mid thickness of bifacial tools (n= 211).

Weight of complete bifacial tools - Most of the axes (72%) weigh between 11-30 g. as opposed to 53% of the roughouts. Another 42% of the roughouts weigh between 31-80 g. as opposed to only 28% of the axes. Roughouts are generally slightly heavier than shaped axes. This slight difference supports the assumption that many of the roughouts reached final stages of manufacture before being discarded. These results indicate that we are dealing with relatively light bifacial tools. Average weight of complete axes (n= 95) and chisels (n= 13) is 26.5 g and 20.9 g respectively.

Cutting edge angle of bifacial tools (Fig. 20) - Most of the axes (68%) have a cutting edge angle between 50-65 degree, as opposed to only 41% of the roughouts. Another 42% of the roughouts, as opposed to only 20% of the axes, have a cutting edge between 70-90 degree. It seems that the preferable angle for axes was in the neighborhood of 60 degree, but it must be kept in mind that we are dealing with discarded axes. It could be possible that some of these axes were discarded **because** of unsuitable cutting edge angle and thus these results should be regarded as representing discarded axes and not necessarily useable axes (e.g. Fig. 3:1,2). The cutting edge angles of roughouts are usually more blunt than the axes, with 28% of cutting edge angles of roughouts which ranges between 80-90 degree.

In some cases the cutting edge angle of the non-shaped or the bifacially flaked tips of roughouts is already at the desired range of around 60 degree. These could indicate a preparation stage before applying the transverse blow, aimed at marking the path of the tranchet blow, or a selection of specific blanks for axe production. The blunt cutting edges of many of the roughouts could be explained by the reconstruction of the operational sequence of axe production, placing the cutting edge modification at the end of this sequence. It is argued that many of the roughouts reached an advanced stage of manufacture, including shaping by bifacial flaking and in some cases preparing the tip for transverse removal, but were discarded prior to the final stage of applying the transverse blow.

Transverse spalls - The by-product of the tranchet technique, the transverse spall, is well known in the archaeological literature and is often described as "orange peel" (Shafer and Hester 1983).

Only 20 transverse spalls were collected at NL 109. This small number of spalls may be

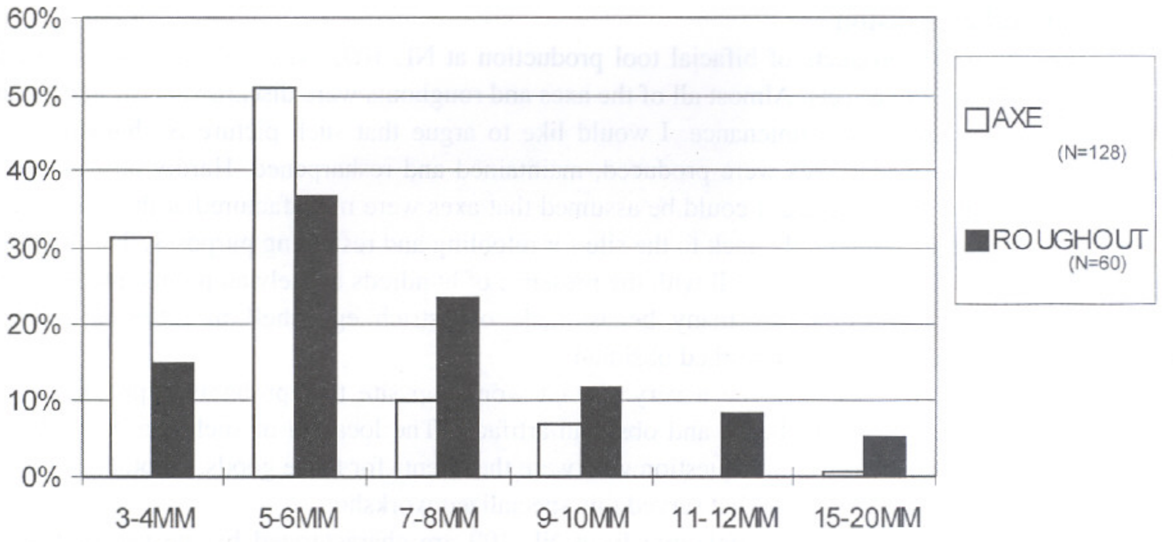

Fig. 19: Base thickness of bifacial tools (n= 188).

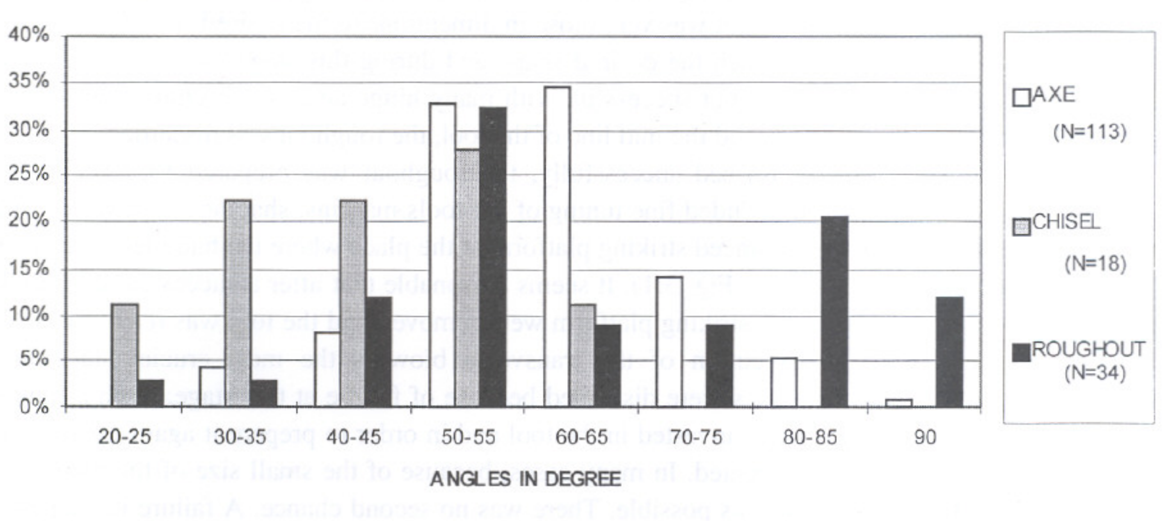

Fig. 20: Cutting edge angles of bifacial tools (n= 165).

explained by the collection method of the non-grided area and the fact that most of the reports on lithic assemblages containing transverse spalls were published in the 1980's and thus transverse spalls were not well familiar to the collectors in the early 1970's.

It is assumed that many more transverse spalls should be found at NL 109 and indeed during a visit to the site in early 1999 many transverse spalls were observed on the surface.

Three of the transverse spalls are primary spalls, still carrying the bifacial ridge that guided the tranchet blow. The other 17 spalls are secondary spalls, carrying on their dorsal surface scars of previous transverse blows. These spalls represents both primary shaping of axes and resharpening of axes that were previously shaped by transverse blows. Thus the transverse spalls supports the suggestion that axes were produced and maintained at the site. The spalls are made of high quality raw material, identical to the raw material used for axe production. Half of the spalls were flaked from the left end of the ventral face while another half was flaked from the right end. Transverse spalls appear in a wide range of sizes, representing different stages of axe production and resharpening.

Discussion and conclusion

The two major products of bifacial tool production at NL 109, axes and roughouts, have one thing in common - all are rejects. Almost all of the axes and roughouts were discarded at the site because of failure in manufacture or maintenance. I would like to argue that such picture is characteristic of specialized workshop where axes were produced, maintained and resharpened. Hardly any usable axe was found at the site and therefore it could be assumed that axes were manufactured at the site, taken to be used elsewhere and then brought back to the site for retooling and reshaping purposes. This picture of a specialized axe workshop accords well with the presence of hundreds of Helwan points, many of them in different stages of manufacture, many beads made of ostrich egg shell in different stages of manufacture and large quantities of worked obsidian.

Nahal Lavan 109 seems to be a very special workshop site that probably supplied precious goods such as axes, arrowheads, beads and obsidian artifacts. The location of such site in the Central Negev remains unclear, as well as the question who were the clients for these goods. Another point to be solved is the sources of raw material that served this specialized workshop.

The axes and axes to be (roughouts) from NL 109 are characterized by the use of fine raw material, a preference of thin blades and flakes as blanks and the use of transverse blows for shaping the cutting edge. As was noted earlier, axes are relatively small, thin and light that were most probably used for light and fine woodworking (Keeley 1983). It could be suggested that the function of these tools is different than the larger and heavier axes of the Middle and Late PPNB.

Since this is a workshop assemblage, the manufacturing process of axes could be reconstructed. Axe production started with a blank that was very close in dimentions to the desired tool. The blank was first shaped by bifacial flaking to reach the desired shape and during this stage the tool mid thickness was fixed. If the bifacial blows were not successful, with many hinge and step fractures and with only small number of flakes traveling beyond the mid line of the tool, the roughout was discarded.

If the first stage was preformed successfully, the roughout was prepared for executing the transverse blow. This preparation included fine tuning of the tools margins, shaping the desired ridge to guide the blow and creating a pronounced striking platform at the place where the hammerstone is about to hit (see remains of this platform at Fig. 3:1). It seems reasonable that after a successful execution of the tranchet blow the remains of the striking platform were removed and the tool was ready for use. As we know from NL 109, the execution of the transverse blow is the most crucial stage in the manufacturing process and many axes were discarded because of failure at this stage. Such a failure is really costly, since a lot of effort was invested in the tool and in order to prepare it again for transverse blow the whole process must be repeated. In many cases, because of the small size of the blanks, only one attempt of the transverse blow was possible. There was no second chance. A failure in shaping the cutting edge led, of cource, to the abandonment of the tool. Many of the bifacial tools were broken during manufacture and discarded at the site. It could be suggested that a relatively large number of production breaks should be anticipated when using thin blanks.

After the axe was successfully shaped it was probably taken to be used elsewhere and brought back to the site if a need arose to reshape, resharpen or replace the tool in the haft (retool). The "repair" stage of axes started with bifacial flaking for reshaping the tool and preparing it for the transverse blow. If the repair went according to the plan, the tranchet blow was executed. A successful performance resulted in a reshaped axe while a failure will bring to discard. An additional stage of recycling discarded axes is also represented, though in small numbers. In some cases broken or discarded axes were transformed into cores or burins (Fig. 5:2).

It should be emphasized that no use of polishing the cutting edges of axes or chisels was identified at NL 109.

Only two axe workshops from the southern Levant were previously published (Ronen and Davis 1970, Taute 1994). In both cases no detailed description of the lithic industry is provided and thus a comparison to NL 109 results is impossible. In any case, both of these workshops are dated to the later PPNB and no use of transverse blows is known to date from these sites. NL 109 is the only tranchet axes workshop as yet known in the southern Levant.

Two extensive Maya tranchet axe workshops from Colha, Belize, (Shafer 1985) bear some technological characteristics similar to those of NL 109. Large numbers of bifacial tools were found in the two workshops and many of these tools (90%) were described as rejects of axes. Only 9% of the axes were found in a usable condition. The assemblages included both axes and roughouts that were discarded because of breakage, flaking failures and unsuccessful shaping. The resemblance to NL 109 is striking. Despite the gaps in time and space, NL 109 and the Colha workshops seem to be twin sites. I believe that the reason for these similarities lies in the end product. The production sequence of axes shaped by transverse blows is most complicated and demands high skills and capabilities. There was no room for mistakes and the work must have been done by skilled knappers. It is no wonder, than, that where tranchet axes are in use specialized workshop or "axe factories" are to be found.

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