

A Preliminary Microwear Analysis of Borers from Hatula, Israel

by Romana Unger-Hamilton, London, Avraham Ronen, Haifa * and Monique Lechevallier, Paris

Introduction

The site of Hatula is located at the western foot of the Judean hills, at an altitude of 200 m above sea level overlooking the plain of Ayalon (fig. 1). The site occupies 2 500 to 3 000 sq.m. at the border of a rocky slope and the alluvial river bank of Nahal Nahshon, a location well suited for the exploitation of the hilly Mediterranean biotope, the river bed and the large plain. Three cultural entities were encountered at Hatula, occupying the same area: the Natufian on bedrock, overlain by two facies of the PPNA, the Khiamian and an 'evolved Khiamian', or Sultanian (Ronen and Lechevallier, 1985; Lechevallier and Ronen, 1985; Lechevallier et al., in press). The stratigraphic relation of the two latter units is not yet clear, as they were found some 30 m apart.

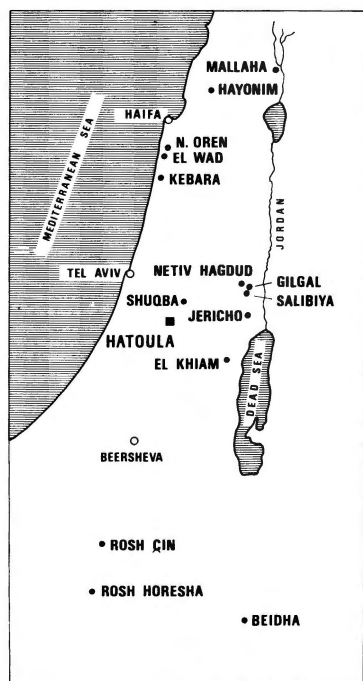


Fig. 1. Map showing Hatula and other Natufian and PPNA sites.

In both units of the PPNA oval houses were found. The Natufian did not yield any structures, but only a small area of it was excavated. The main food source of the three cultures was apparently gazelle, accompanied by a few other animal species, such as birds, Mediterranean fish and molluscs. The remains of water fowl are interpreted as evidence of marshes, or a small lake in the vicinity of the site. It seems that, compared to the Natufian, birds and fish became more important as a food source in the PPNA, but the analysis is still in progress (Pichon and Davis, pers. comm.). Numerous grinding and pounding implements indicate, especially for the Neolithic, the importance of plant food which could, however, not be identified.

All three cultural entities at Hatula yielded rich lithic assemblages which have been described in the references quoted above. The borers recovered from this site are particularly interesting; they can be divided into several typological categories all of which occur in all three industries at Hatula but with a noticeable chronological shift in frequency: there are 3.8 % borers in the Natufian (of a total of 1483 tools), 17.4 % borers in the Khiamian (of a total of 705 tools) and an astonishing 28.5% borers in the Sultanian (of a total of 1550 tools, Lechevallier et al., in press). This study is a preliminary attempt to determine the function of the Hatula borers through microwear analysis. Only borers from the Khiamian levels were available for study.

All three cultural entities at Hatula yielded rich lithic assemblages which have been described in the references quoted above. The borers recovered from this site are particularly interesting; they can be divided into several typological categories all of which occur in all three industries at Hatula but with a noticeable chronological shift in frequency: there are 3.8 % borers in the Natufian (of a total of 1483 tools), 17.4 % borers in the Khiamian (of a total of 705 tools) and an astonishing 28.5% borers in the Sultanian (of a total of 1550 tools, Lechevallier et al., in press). This study is a preliminary attempt to determine the function of the Hatula borers through microwear analysis. Only borers from the Khiamian levels were available for study.

* En 1988, Centre de Recherches Archéologiques, CNRS, Meudon, France.

The Borers from Hatula (R. and L.)

The tips of the Hatula borers are in most cases very delicate, suggesting the term „needle-tipped borers“. Most frequently the tip was made on the distal end (fig. 2) and less frequently on a lateral edge (fig. 2; 8), or more rarely on the butt. About 10 % are double borers with a tip at each end. The smallest borer in this study measures 9 × 11 × 2.5 mm (fig. 2; 14); the thinnest piece is 1.2 mm thick (fig. 2; 13).

The borers can be divided into three major types according to the shape of the tip:

1. needle-tipped borers
2. thicker-tipped borers
3. drills

Type 1 is the most common at Hatula (fig. 2; 1–15). Made on a thin flake or blade, the tip is formed either by two retouched edges (direct, inverse or alternate, fig. 2; 1–8) or by the intersection of a retouched notched edge and a broken distal end (fig. 2; 9–15). The break may have been made deliberately, as in some cases a bulb of percussion is noticeable. The last variety, quite typical of Hatula, constitutes nearly one half of the borers. Type 2 is an ordinary borer with the tip formed by two retouched edges (fig. 2; 16). Type 3 is made on a narrow, massive blade with the edges completely retouched (fig. 2; 17).

Of the eighteen borers from Hatula which were subjected to microwear analysis fifteen were needle-tipped borers, two were thicker-tipped borers and one was a 'drill'.

The Functional Analysis of Borers (U.-H.)

A number of studies have been devoted to flint borers, perhaps the first important one being that of Semenov (1964, 74–83) who examined perforated shell and stone objects from the Upper Palaeolithic and the Neolithic. He illustrated (*ibid.*, fig. 25) various methods of boring with a hand-held tool, drilling with a stone drill inserted in a shaft and rotated between the palms of the hand, and drilling with a bow-drill which appears to have been used in the Levant at least by Neolithic times (Cauvin, 1968, 163; Unger-Hamilton 1985, 184). Other studies of drills include that of Tosi and Piperno (1973) who found lapis lazuli embedded in perforators made from blades and burin spalls at Tepe Hissar and Shahr-i-Sokhta in Iran. Microwear analysis of Paleo-Indian drills (Yerkes, 1983) suggested that shell, bone, wood and stone were drilled, probably with a bow-drill. Traces from fast mechanical drilling of shell (and probably of soft stone, with the addition of abrasives) were found on drills from Abu Salabikh (Unger-Hamilton et al. 1987). Gwinnet and Gorelick, in their scanning electron microscope study of ancient drilling methods (1979), reported concentric patterns resulting from the use of abrasives in drilling. These traces were similar to those observed by the author with an optical microscope on experimental drills, as well as on drills from Abu Salabikh (Unger-Hamilton et al. 1987). Wear traces on long 'meches de forets' from Neolithic Abu Hureyra (Keeley 1983) and from 5th millennium BC Arjoune (Unger-Hamilton 1985) suggested that these tools had been used to drill wood.

The Microwear Analysis

The microwear analysis is based on the method pioneered by Keeley (1980). This method involves making copies of the ancient tools, using the copies in experiments, and comparing the wear traces (in

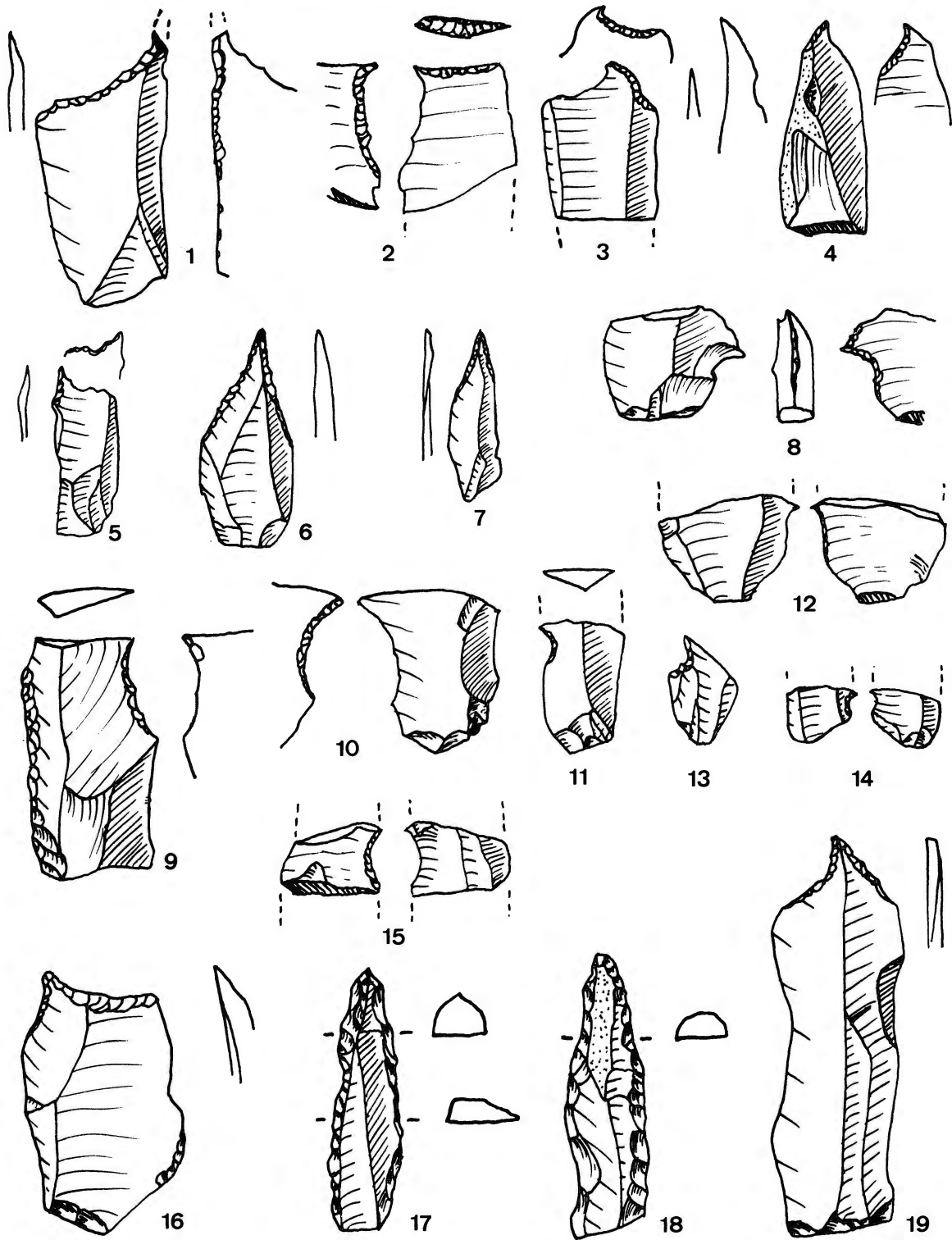


Fig. 2. Borers from Hatula (n° 1-17) and replicas (18, 19).

the form of polish and striations) on both the copies and the ancient tools by means of an incident light microscope. The aim is to establish how the ancient tools had been used and which material they had been used on. As part of a Ph. D. programme (Unger-Hamilton 1985) I subjected this method to a critical analysis and found that – because of the similarity of wear traces from different materials and the great number of variables involved in the formation of such traces – the possibility of error was far greater than Keeley and others seem to have suspected. The results of recent ‘blind tests’ (Newcomer et al. 1986; Unrath et al. 1986) have confirmed this. However, it also appeared that when examination was confined to one class of tool – that is when a wide range of experiments could be carried out – microwear analysis could be a reliable method to investigate precise contact materials, in particular when both action and general type of contact material were suggested by tool shape and macroscopic lustre: such seemed to be the case with spindle-tipped borers from Abu Salabikh (Unger-Hamilton et al. 1987). The results of the microwear analysis which indicated that shell and stone were drilled (mechanically) matched the finds (drilled shell, carnelian and lapis lazuli) from the site (Payne, 1980). We did not know what materials had actually been found at the site until after the analysis was complete.

The Method

The method used in the present study involved an extensive experimental programme using a variety of borers (used manually) and drills (used mechanically) on a wide range of materials which may have been perforated or drilled in the Near East, which included copies of the Hatula tools (fig. 2; 18, 19). The drills were used in a bow-drill constructed by C. Bergman (Unger-Hamilton et al. 1987). The experimental tools and the ancient tools from Hatula were cleaned with ammonia-free detergent and with distilled water in an ultrasonic cleaning tank. Hafting agents such as resin were removed by immersing the implements in white spirit for 24 hours. The implements were examined with an Olympus Vanox light microscope at M 50–200x and photographed using Ilford FP4 film. All photographs are shown at M 200x unless otherwise stated. Most importantly, not only polish and striations, but also the edge damage was studied as it too appeared to be an indication of past tool use (Tringham et al 1974). ‘Hafting’ or ‘prehension’ traces were not investigated as our experiments (Unger-Hamilton et al. 1987) and analysis by means of computer imaging techniques (see Grace, *ibid.*) led us to doubt whether such traces could be reliably observed after damage caused by thousands of years of burial. .

The Experiments and their Results

Twenty six borers and 32 hafted drills were made (fig. 2; 18, 19) of various types of flint (mostly fine-grained) from Brandon in England and from France and Syria. The raw material, also fine-grained (see below), from which the Hatula borers were made was, unfortunately, not available to me. The experimental borers were used to perforate ash and cherry wood (fresh and seasoned), leg bones and ribs (cooked, uncooked and dried) from various animal species, the antler (soaked and dry) of fallow and roe deer, cow horn, soft stone (limestone excavated from EB Jericho), cane, and cardium, scallop and dentalium shells. Dr. Bergman and I used a bow-drill on most of these materials. A harder stone (lapis lazuli) was drilled, and limestone and wood were bored, with the addition of abrasives. Some of the tools were used for between 5 and 36 minutes but the majority for about 10 minutes.

The only wear traces I shall describe are those which are relevant to the tools from Hatula. For a detailed description of the experimental work and its results see Unger-Hamilton 1985, 177–181 and Unger-Hamilton et al. 1987, though this did not include experiments with copies of needle-tipped

borers. Such borers could be used to perforate wood and soft stone but broke on harder materials (see below).

Traces left by the process of retouching the borers and drills were examined before experimental use. Retouch with antler tine left only a few weak striations, while retouch with a hammer stone very occasionally left strong hammer stone 'smears' (Unger-Hamilton 1985, pl 6). None could be discerned on the six needle-tipped borers I made.

If developed enough polish and striations made by rotary motion could usually be reliably distinguished from those made by grooving, since their distribution on the tool's surfaces are different. On a tool used for grooving, polishes and striations are confined to the contact aspect and run along the long axis of the tool tip. Such traces are mainly perpendicular to the tool's long axis.

Traces from boring and fast mechanical drilling could be differentiated. Boring involved either considerable edge flaking (from bone), or abrasion (from limestone and shell) but only little polish and slightly random striations. Fast mechanical drilling, on the other hand, caused hardly any edge flaking (apart from breaking of the tips), but strong abrasion and strong polish, often with rotational striations. Macroscopic lustre (see Unger-Hamilton, 1985, 74) could sometimes be seen on drill tips used on stone or wood.

There were some appreciable differences in the wear traces on hand-held borers from making several holes each into wood, pottery and limestone (fig. 3). Boring limestone caused no edge flaking but slight abrasion and a flat, very bright polish with a number of short striations. A large number of striations, probably from flint particles, were seen on all borers of hard materials. This made it impossible to differentiate shell (fig. 4) from bone polish, both of which caused a somewhat 'inflated'* looking bright polish with striations. Nevertheless, the fact that bone appeared to cause edge flaking, while shell appeared to cause abrasion rather than flaking, suggested that the wear traces could be distinguished. Fine tips such as of the needle-tipped borers remained intact when used to perforate wood and soft limestone but broke on bone or shell. Thicker tipped borers had to be used on the latter materials which were not easily perforated.

Bow-drilling different materials left traces most of which looked appreciably different. Drilling limestone caused a flat bright polish typical of use on stone (cf. above, fig. 5) with rotational striations and macroscopic lustre at the tip.

The Borers from Hatula

Most of the examined borers from Hatula were made of fine-grained flint, pale beige to brown in colour. They appeared to be in mint condition and no signs of rolling, random edge damage or breakage of the fine tips could be detected. Only three of the implements were overall affected by a faint macroscopic lustre, probably patina. Microscopic evidence of post-depositional surface alterations consisted of a slight brightening of the flint surface, most strongly developed on the three tools with macroscopic lustre, and some random very fine striations (fig. 6).

On only two borer tips could edge flaking be discerned with the naked eye; this led me at first to suspect that the tools were either unused or else used on a soft material. Microscopic inspection revealed slight abrasion in the form of rounding of all the tips. In two cases one or two chips had been removed from the tip parallel to its long axis.

Polish and striations (fig. 7) were present in all cases except on the two extensively flaked tips. The wear-traces looked identical from tool to tool, and identical to the abrasion and the polish and striations

* This term has no bearing on my understanding of the process involved in polish formation.



Fig. 3. Experimental borer used on limestone, ventral aspect of the tip.



Fig. 4. Experimental borer used on dentalium shell, ventral aspect of the tip.



Fig. 5. Experimental drill used in a bow-drill on limestone, ventral aspect of the tip.

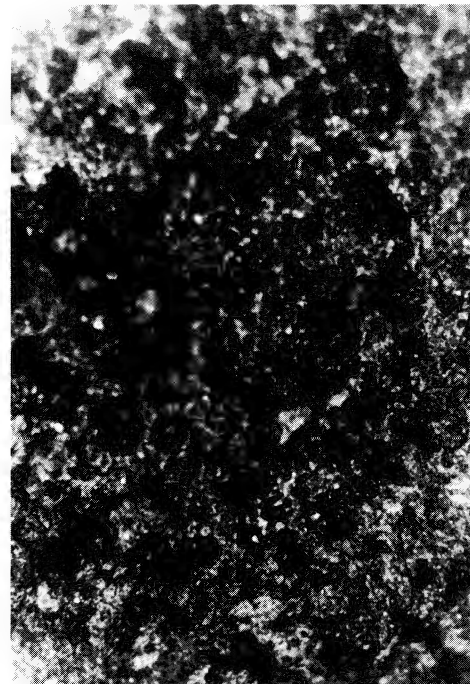


Fig. 6. Polish and striations, probably post depositional, on bulb of a borer from Hatula.

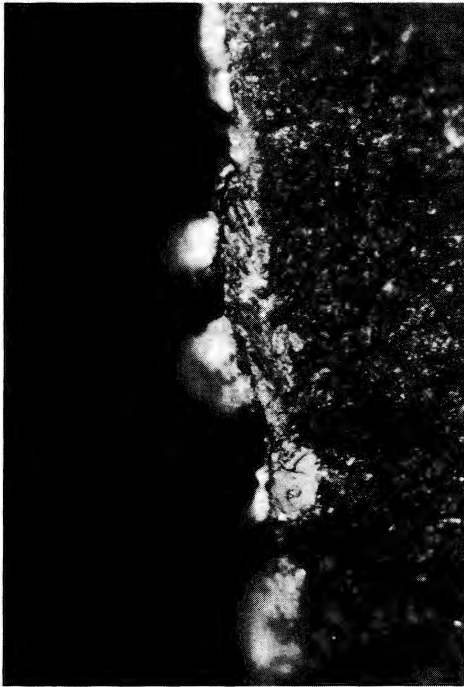


Fig. 7. Polish and striations on a needle-tipped borer from Hatula, ventral aspect of tip.

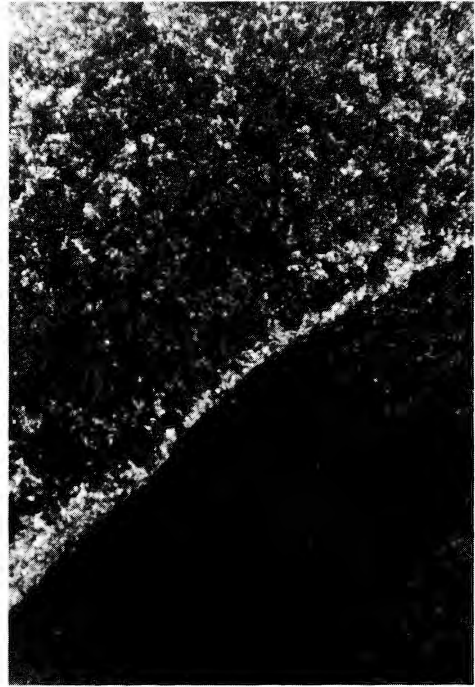


Fig. 8. Polish and striations on the notch of a needle-tipped borer from Hatula, M 50x, ventral aspect.



Fig. 9. Polish and striations on thicker tipped borer from Hatula, ventral aspect of tip.



Fig. 10. Polish and striations on a „drill“ from Hatula, ventral aspect of tip.

on borers used on soft limestone: a very bright, flat polish with short striations running both parallel and perpendicular to the tool axis (fig. 7). The polish extended ca. 2 mm down the tip. In addition a strong polish similar to experimental stone polish along one lateral edge of some of the tools (fig. 8) suggested that this particular edge had come into contact with the worked material. The relative weakness and distribution of the traces, the width of the blanks, as well as the off-centre position of the tips, ruled out the possibility that the needle borers had been used hafted in a drill.

Two thicker-tipped borers also had intact tips with slight abrasion. The polishes (fig. 9) were bright but slightly more 'inflated' looking than those on the needle-tipped borers, with some striations. The traces on these two tools resembled experimental traces from boring shell, or else soft stone. The weakness of the traces and the shape of the tools (one had a wide blank, the other a curved section) ruled out the likelihood of their having been hafted in drills.

One straight 'drill' (fig. 2; 17) had a generally lustered surface, probably due to incipient patination. However, a lustre concentration was visible with the naked eye on the heavily abraded tip. Strong flat micro-polish at the tip and rotational striations (fig. 10) down to 10 mm below the tip suggested that this tool had been used to perforate soft stone, in a fast drill.

The Perforated Limestone Beads

The majority of perforated objects at Hatula are shell beads from the small Natufian excavation, and stone beads from the PPNA levels. The stone beads were made of white and pink limestone, as well as of soft greenstone. There are small beads with single (fig. 11; 5, 6) or double (fig. 11; 7) perforations, cylindrical beads with bi-polar perforations (fig. 11; 1-4), and large cylindrical beads with two or even three parallel perforations. The bi-polar drilling was not symmetrical, as is demonstrated in fig. 11; 1-3 and fig. 11; 4 which depicts a bead split lengthwise. It should be noted that the craftsmen at Hatula managed to make holes 15-18 mm long, but only 5-6 mm wide (fig. 11; 1, 2). A hole which was 10 mm long had a width of 4 mm (fig. 11; 3).

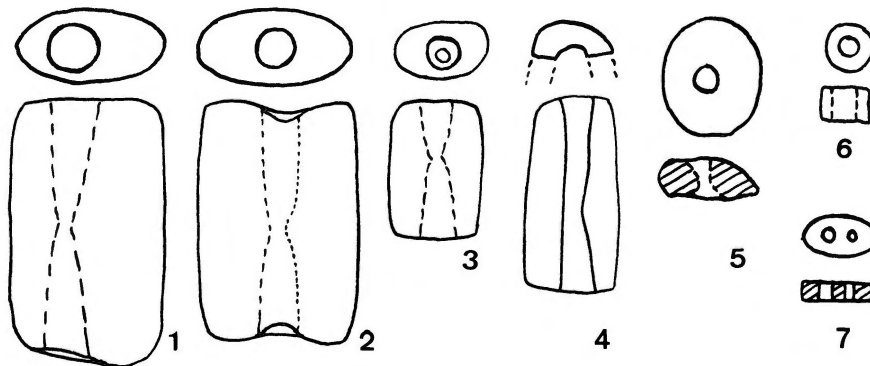


Fig. 11. Perforated stone beads from Hatula.

Conclusions

The microscopic study of 18 borers from the Khiamian layers at Hatula revealed what appeared to be extremely well preserved and consistent wear traces. The evidence from experiments using replicas (made of similar but not the same flint) suggests that the needle-tipped borers had been used manually to bore

soft stone, most likely the perforated limestone beads found at the site (fig. 11). The delicate notches of the borers appear ideal to accommodate the curvature of the beads during the work. The thicker tipped borers which I examined may have been used to bore shell manually. Perforated shell was found at Hatula (*ibid.*). However, the possibility that soft stone was bored could not be ruled out. The 'drill' (*ibid.*) appears to have been used as a fast drill, also on soft stone, and it is possible that this type of tool was used at Hatula to complete the perforation of the limestone beads. As far as the large cylindrical beads are concerned, the flint borers may well have been used to start the perforations, while other tools, perhaps of wood or bone, must have been used to complete them.

The results of this analysis of eighteen borers from the Khiamian levels suggest that a more comprehensive analysis of the Hatula borers is worthwhile. Such a study should perhaps concentrate on possible functional and technological differences between borers from the Natufian, Khiamian and Sultanian entities, in particular, the introduction of the fast drill.

Thanks are due to Dr. Christopher Bergman and Dr. Mark H. Newcomer at the Institute of Archaeology, University of London.

Bibliography

- CAUVIN, J., 1968: Les outillages néolithiques de Byblos et du littoral libanais. Fouilles de Byblos IV. A. Maisonneuve, Paris.
- GWINNET, A. J. and GORELICK, L., 1979: Ancient lapidary. *Expedition* 22 (1), 17–32.
- KEELEY, L. H., 1980: *Experimental Determination of Stone Tool Uses: a Microwear Analysis*. The University Press, Chicago.
- , 1983: Neolithic novelties: the view from ethnography and microwear analysis. In (CAUVIN M.-C., ed.). *Traces d'Utilisation sur les Outils Néolithiques du Proche Orient*, 251–256. Travaux de la Maison de l'Orient 5, Lyon.
- LECHEVALLIER, M. and A. RONEN, 1985: Le Site Natufien-Khiamien de Hatoula, près de Latroun, Israel. Fouilles 1980–1982, Rapport préliminaire. CRFJ No. 1. (With contributions by ARENSBURG, B; DAVIS, S. J. M.; GOLDBERG, P; LAVILLE H.; LERNAU, H.; PICHON, J.; and SMITH, P.).
- LECHEVALLIER, M., PHILIBERT, D., RONEN A. and SAMZUN A.: *L'Occupation khiamienne et sultanienne de Hatoula*. (In press).
- NEWCOMER, M. H., GRACE, R. and UNGER HAMILTON, R., 1986: Investigating microwear polishes with blind tests. *Journal of Archaeological Science* 13, 203–217.
- PAYNE, J., 1980: An Early Dynastic III flint industry from Abu Salabikh. *Iraq* 42, 105–120.
- RONEN, A. and LECHEVALLIER, M., 1985: The Natufian-Early Neolithic site Hatula, Near Latrun, Israel. *Quartär* 35/36, 141–164.
- SEMENOV, S. A., 1964: *Prehistoric Technology*. Cory, Adams and Mackay, London.
- TOSI, M. and PIPERNO, M., 1973: Lithic technology behind the ancient lapis lazuli trade. *Expedition* 16 (1) 15–23.
- TRINGHAM, R., COOPER, G., ODELL, G., VOYTEK, B. and WHITMAN, A., 1974: Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1, 171–196.
- UNGER-HAMILTON, R. 1985: *Method in Microwear Analysis: Sickle-Slades and Other Tools from Arjoune, Syria*. Ph. D. thesis, University of London.
- UNGER-HAMILTON, R., GRACE, R., MILLER, R. and BERGMAN, C. A., 1987: Drill-bits from Abu Salabikh, Iraq. In (STORDEUR, D., ed.) *La Main et l'Outil*. Travaux de la Maison de l'Orient, No 15, 269–285.
- UNRATH, G., OWEN, L. R., VAN GIJN, A., MOSS, E. H., PLISSON, H. and VAUGHAN, P., 1986: An Evaluation of Microwear Studies: A Multi-Analyst Approach. *Early Man News* 9/10/11, 117–176.
- YERKES, R. W., 1983: Microwear, microdrills and Mississippian craft specialisation. *American Antiquity* 48 (3), 499–518.