Traces et fonction : les gestes retrouvés
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Horn experimentation in use-wear analysis

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RÉSUMÉ

La corne était une matière travaillée pour de multiples usages dans les groupes de chasseurs-cueilleurs préhistoriques et plus récents. La tracéologie lui a jusqu'ici accordé peu d'attention. C'est pourquoi on a travaillé de la corne avec différents outils en silex dans des expériences contrôlées. Les surfaces d'outils utilisées ont montré au microscope une formation substantielle de micro-usure Cela peut être intéressant pour une prochaine analyse tracéologique.

ABSTRACT

Horn was a multipurpose worked material for prehistoric and more recent hunter-gatherer groups. In use-wear analysis it has received little attention so far. Therefore horn was worked with different flint tools in controlled experiments. The used tool surfaces showed well developed microwear under the microscope. This may be of value for future use-wear analysis.

Introduction

Horn is a widely available and easily obtainable material. Horned animals, *e. g.* cattle, antilope, sheep and goats, live in almost all climates. In contrast to antler, horn consists almost completely of layers of keratin which are laid down over horn-cores, bony protuberances on the skull (Hodges, 1964 : 153-155). It is a relatively soft and elastic material which can be easily worked. Horns can be removed from the horn-cores without much difficulty, especially after a short period of decay has broken down the connective tissue. However the horn itself also rots somehow, and the upper layers begin to flake off, especially at the base.

The main component of horn, keratin, has a high sulphur content and decays quickly. Archaeological finds can therefore not be expected in older sites. However, evidence that horn was used in the Paleolithic is shown by the Venus relief of Laussel, France. Ethnographic reports on hunter and gatherer groups of northern North America show that the natural shape of horn was often utilized for making containers. In addition, horn was used to produce parts of composite bows, handles, sections of weapons and tools, ornaments and musical instruments (Owen, this volume).

Although horn was not an unimportant worked material for prehistoric and more recent hunter and gatherer groups, it has received little attention in research directed toward microscopic use-wear analysis so far. There are only terse comments which state that working horn, even for long periods, left only scant use-wear traces, with polish similar to that caused by working antler for a short period : « Très marginal, de coalescence dure ondulée unie, le plus souvent en forme de spots, ce poli peut être confondu avec celui produit par un très bref travail de bois de cervidé. » (Plisson, 1985 : 59). It therefore appeared advisable to carry out a series of experiments with horn. The skulls of freshly butchered cattle were obtained and left out in the summer sun for a few days. During this time, the connective tissue between the horns and the bony protuberances of the skull had decayed and the horns could be twisted off easily. They were then stored in a dry, dark room for *ca.* 12 weeks before the beginning of the experiments. For this preparatory work I thank Mr Hans Schwarz, Institut für Urgeschichte, Tübingen.

The experimental framework

The natural form of horn is ideally suited for making waterproof containers. Thus, a horn was made into a transportable and sturdy container. The horn was first soaked in water for 48 hours. This made it possible to rub off most of the scaley parts of the surface, present near the base, with the hand.

The actual work with stone tools consisted of the following steps (pl. 1) :

Cutting off the unstable base of the horn

The thickness of the horn, especially near the base, varied greatly. Up to 30 mm from the base, it was under 1.5 mm in parts. In such areas, the horn was fragile when dry and easily damaged. When moist, these areas became soft and gummy and could be formed without difficulty. However, they were also stringy and it was not possible to tear them off in a controlled manner as this at times caused more damage than it helped. It therefore seemed best to remove this edge. A flake with parallel edges (E1/5-90) was used as the cutting tool (pl. 2 : A).

Smoothing the cut edge and scraping off the remaining scales

The horn edge and surface were then finished with a scraper on a blade (E2/7-90) (pl. 2 : B). During this work, the tool and the worked area were repeatedly moistened.

Engraving a circular groove

A circular groove for securing a thong (*e. g.* for fastening on a belt) was then engraved near the horn tip. This was done with a burin (pl. 2 : C) and the addition of water.

Boring a hole near the base

As the last step, a hole for tying the fastening thong was bored near the base. During this activity, care was also taken that the bore hole had sufficient lubrication. The tool utilized was a retouched borer (E4/7-90) (pl. 2 : D).

Documentation of the experiments

After the tools were selected, they were photographed, and prints of 1 : 1 were glued to photocopied protocol sheets. The utilized motions, tool angles and working angles were recorded in detail whenever possible, otherwise briefly. The prehension and handling of the tools were documented with texts, sketches and photographs. The duration of each task and an estimation of the number of strokes were also noted. The duration of a task in time or number of strokes says little about the actual intensity and effectivity of the work carried out. Furthermore, in practice it is hardly possible for an experimenter to give even approximately correct statements about the number of strokes in longer tasks. For tasks that involve cutting, shaving or the removal of some worked material, an assessment of the work done can also be obtained by weighing the worked material and the tool before and after the work. This provides another parameter for judging both the amount of wear and the force used and therefore the actual work carried out with the tool. Of course this method can hardly be used for cutting activities on meat, skin or plants. However, when scraping hide, for example, material is removed from the meat side by a very intensive activity, *i. e.* there is a measurable difference in weight before and after the task. Measurements of this type produce objective and reproducible results, especially for harder materials. An electronic laboratory scale which weighs exactly to one hundredth of a gram is ideal. With this type of scale one can also measure the continuing wear on the tool itself, which is often only very small on experimental tools (Pawlik, 1991).

However, working moist materials or adding liquid as a lubricant or softening agent makes such measurements more difficult as the worked material, horn in this case, takes on a considerable weight of water. After interruptions in work, the pieces must be re-weighed. Special care must be taken, as a single moment of inattentiveness can make any judgment of the amount of work performed impossible. Nonetheless, this method has proved of value and was thus added to the protocol sheets.

The experiments

All the utilized tools were freshly knapped from northern European chalk flint by Mr Harm Paulsen, Landesamt für Vor- und Frühgeschichte, Schleswig, Germany. They were weighed before use and checked for possible micro-traces or special surface characteristics. The tools were all held with the left hand during the experiments.

Cutting off the base of the horn

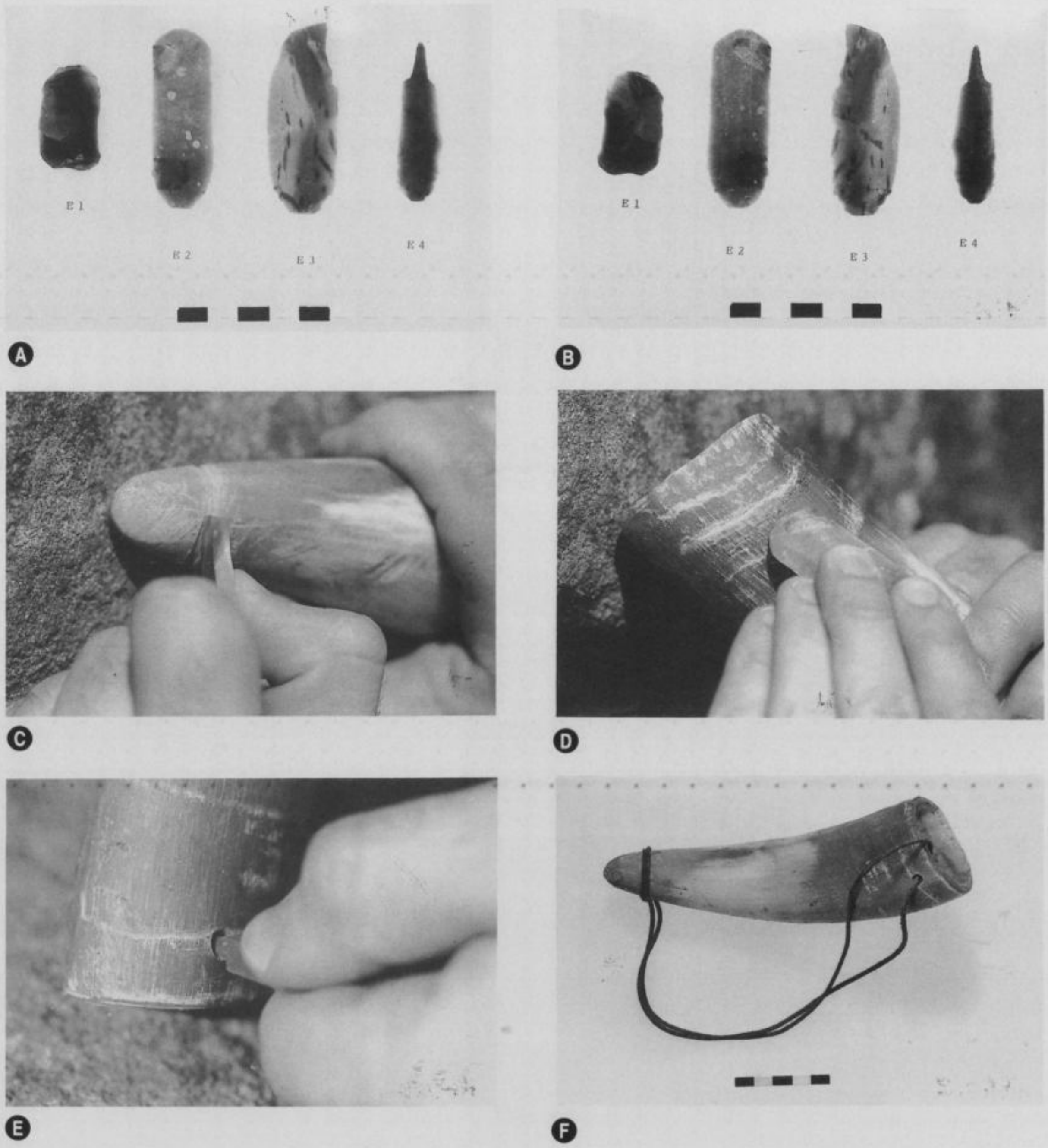
This experiment was done with tool E1/5-90, a flake with parallel and relatively straight edges. To make handling easier, a small sharp corner on the proximal edge was dulled with a limestone pebble. One lateral edge was used throughout for the cutting. It was generally held perdendicular to the surface being worked and moved back and forth under constant pressure. The tool was used for a total of 95 minutes and analyzed after the first 15 minutes and again after another 30 minutes. Although the horn had been soaked in water long enough and the worked area was continuously moistened, there was a noticeable dulling of the tool before the task was half finished (however, not near as much as from the working of dry horn). This is made clear by the differences in the horn weights : a decrease of 1.52 g was measured after the first interval of 15 minutes, but only 0.78 g after the second interval of 30 minutes which was twice as long. In the last 50 minutes, the achievement remained constant, and a difference of 1.55 g was measured. At the end of the experiment, the flake tool showed wear but was still employable. It had lost a total weight of 0.08 g.

Smoothing the cut edge and the surface of the horn

A scraper on a blade, tool E2/7-90, was used for this purpose. The scraper cap was utilized for smoothing the cut edge and the horn surface and a lateral edge was employed for a relatively short period to remove a ridge from the cut edge. The tool was used in short, quick movements in one direction with an acute contact angle (< 20°). The working direction was more or less perpendicular to the height of the scraper cap or the lateral edge, respectively. The smoothing took 33 minutes and resulted in a weight difference of 0.82 g of horn. The trimming with the lateral edge lasted 11 minutes and removed 0.18 g of horn splinters. After the task, there was no visible wear on the tool, even microscopically, and it had only lost 0.02 g in weight.

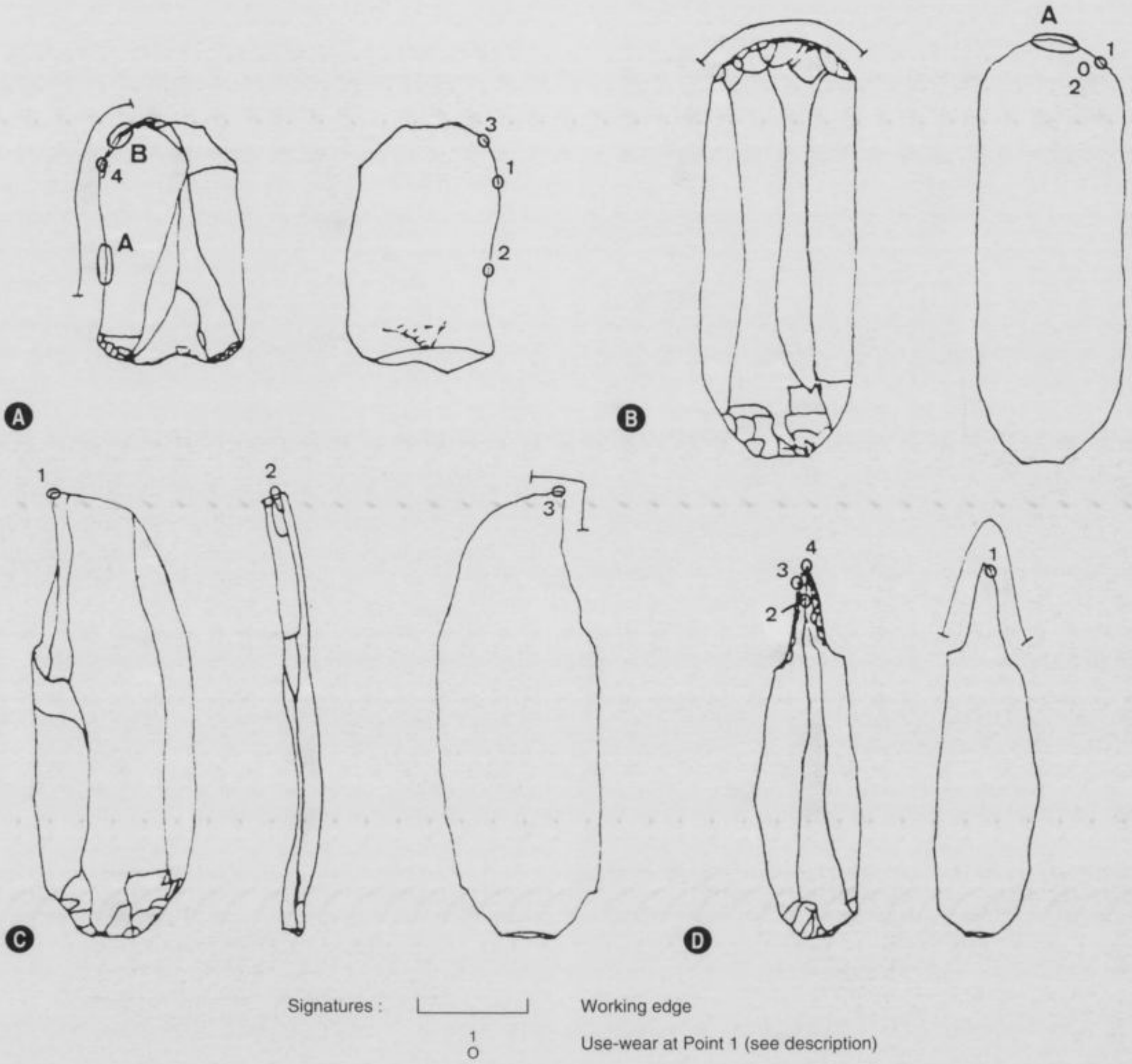
Engraving a circular groove

This task was carried out with a transverse burin (E3/7-90) whose facet was struck along the broken distal end of a blade. The functional area was the burin bit. First, a preliminary circular groove with a V-shaped section was engraved in the horn. For this, the burin was moved in one working direction perpendicular to the burin facet almost at a right angle to the worked material. As always, the worked zone was kept constantly moist. It proved advantageous to work the groove step by step



Pl. 1. Horn Experimentation. **A.** The experimental tools, dorsal surfaces. **B.** The experimental tools, ventral surfaces. **C, D, E.** Stages of the Horn Experimentation. **F.** The finished container.

around the horn. After 42 minutes, a ring with a V-shaped section was finished which had a depth of 0.9-1.0 mm and a maximum width of 2.4 mm. Because of the comparatively small working face of the tool, the horn had only lost 0.26 g in weight in this case. The groove was then widened. For this, the broad side of the burin bit was moved in a working direction parallel to the burin facet. After 33 minutes, a circular groove with a rectangular section 4 mm wide and 1.0-1.1 mm deep was created. The horn showed a weight difference of 0.25 g. No appreciable wear could be discerned on the implement, which weighed 0.03 g less than before the task.



Pl. 2. Utilized tools showing the marked position. **A.** E1/5-90. **B.** E2/7-90. **C.** E3/7-90. **D.** E4/7-90.

Boring

This task was carried out with a long thin blade whose distal end had been worked to a regularly shaped borer point with a slightly conical outline (E4/7-90). The borer was thus well suited for boring holes which could only be undertaken from one surface of the worked material as is the case with cylindrical bodies. The borer was placed perpendicular to the horn surface and moved back and forth with a constant, but not too strong, pressure from the hand joint. It was held directly next to the base of the borer point so that it could be kept from jumping from the desired position. After 8 minutes, a small facet of the borer tip broke off, although this did not affect the work in any way. This caused a weight loss of 0,02 g. No further chipping was noticed. It took 33 minutes to bore through the horn and a further 8 minutes to finish the slightly conical hole, which had an outer diameter of 5.65 mm, an inner diameter of 4.6 mm and a depth of 5.4 mm. The horn had lost a total of 0.24 g of weight. No further weight loss could be ascertained on the borer.

This concluded the working of the horn. A thong could then be fastened to it. All of the tools had served their purpose and could have been utilized further.

The Use-Wear analysis

Before the analysis, the lithic tools were cleaned in an ultrasonic tank with a weak, 0.5 % solution of potassium hydroxide (KOH). In order to avoid contact with the metal sides of the tank, they were placed in a cotton net that hung free in the solution. A cleaning time of 20 minutes was sufficient.

The tools were analyzed with a reflected light microscope and a stereomicroscope. The reflected light microscope is an Olympus Model BHMJ which was developed for metallurgical analyses. It is equipped with the following :

– a 12V/15W halogen bulb and an adjustable transformer ;

– a vertical illuminator with analyzer, polarizer, aperture iris diaphragm, field iris diaphragm and filter mount ;

– a microscope body with coarse and fine adjustment and a quintuple revolving nosepiece ;

– a trinocular observation tube with eyepieces WF10x and micrometer reticles ;

– objectives M10, LWD MPlan20, LWD MPlan40 ;

– a Nomarski differential interference contrast attachment with a magnification factor of 1.1x.

The total magnification lies between 100x and 440x.

The stereomicroscope is also an Olympus, Model SZTr. It is equipped with a zoom objective and allows a continuously adjustable magnification between 7x or 14x to a maximum of 40x or 80x depending on the objective used.

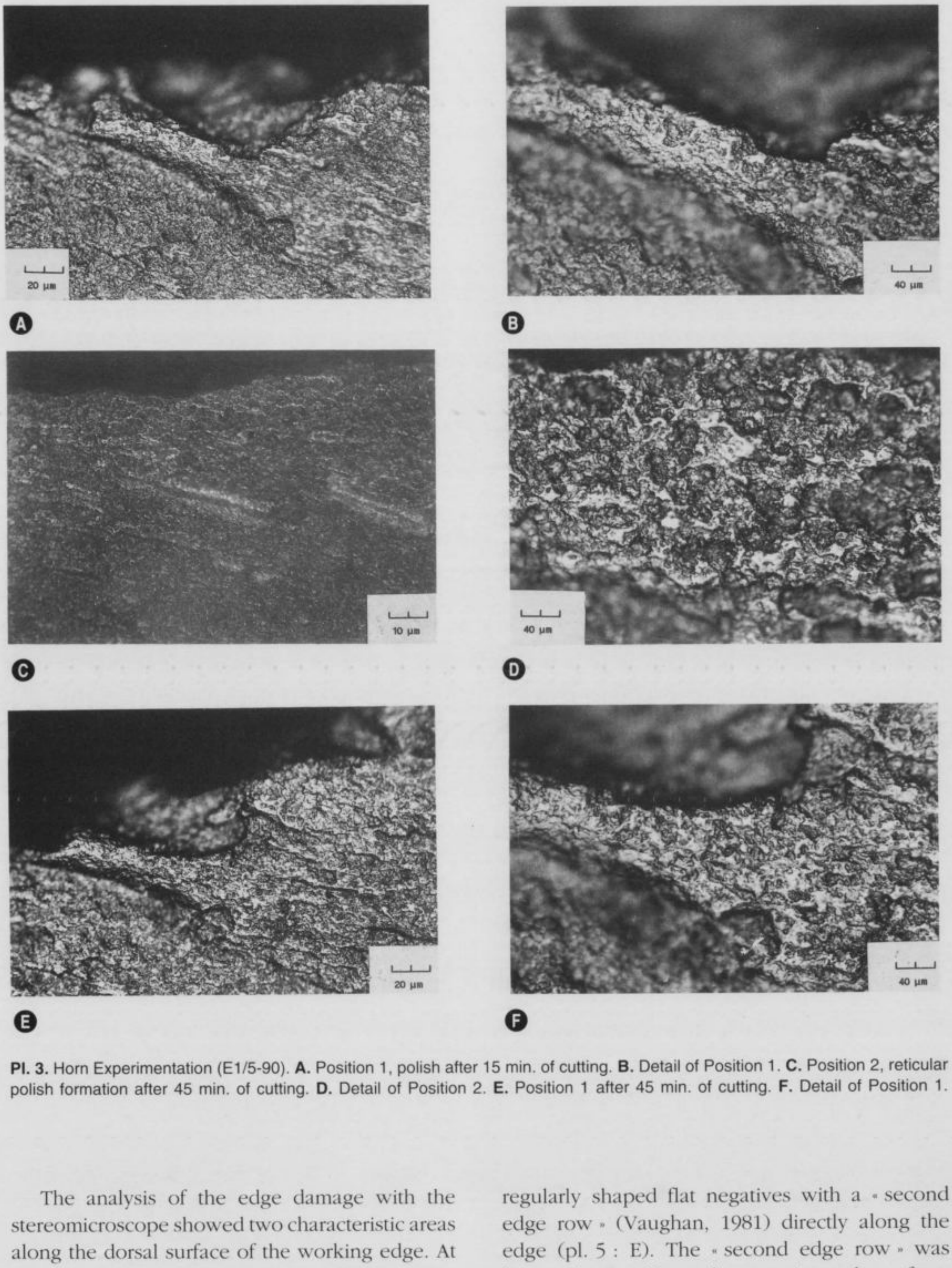
The photomicrographic equipment includes a SLR camera body Olympus OM2N with a winder, an integrated light measurer and a time automatic (up to 120 seconds) as well as a photo eyepiece NFK 3.3XL. The camera is connected to the microscope with the photomicro adapters L and PM-ADF.

Use-wear traces from longitudinal motions

On the edge of the tool used for cutting (E1/5-90), an easily recognizable use-wear polish could be seen on exposed high areas after just 15 minutes. This appeared to be brightly reflective and was clearly delimited from the inner surface. The surface of the polish was slightly convex and characterized by micropits up to 1 µm across. In addition, there were also irregular crater-like depressions (pl. 3 : A, B - Pos. 1).

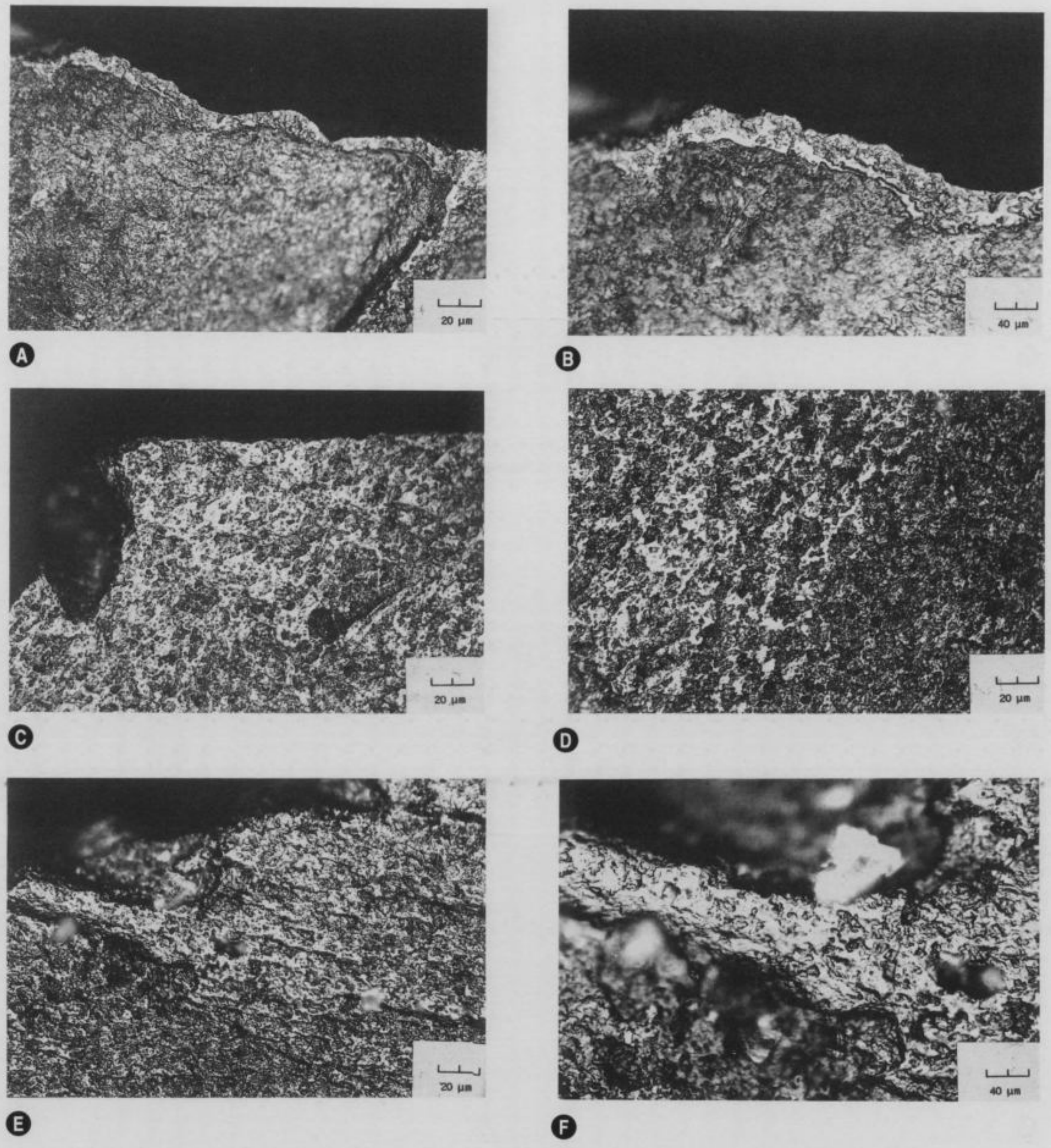
After another 30 minutes of cutting, the polish had spread in a reticular manner along the working edge and was ca. 300 µm wide (pl. 3 : C, D - Pos. 2). The polish at Position 1 had not increased considerably, only a weak spreading of the polish onto the lower lying areas of the microtopography could be ascertained (pl. 3 : E, F - Pos. 1). The formation of a polish bevel, often observed during the working of middle-hard to hard materials (Vaughan, 1981, 1985), was absent to a large extent. At Position 3, the suggestion of such a bevel could be observed on the edge and on the ridge of a microchip. The edge line was, however, clearly raised above the inner surface of the negative. In comparison to the other polish, this one was more reflective, micropitting was missing and only a few crater-like depressions could be observed (pl. 4 : A, B - Pos. 3). An advanced connection of the « polish nets » had already occurred on the dorsal surface. On the surface of the polish, fine striations running in the working direction were vaguely visible, but could not be resolved with the camera. Edge rounding was observed at a magnification of 220x (pl. 4 : C). A clear delimitation between the polish and the inner surface still predominated, as at Pos. 4 dorsal, ca. 1.4 mm from the edge (pl. 4 : D).

At the end of the task (after another 50 minutes), the polish bevel at Pos. 3 had almost completely disappeared. A leveling and rounding of the edge line had apparently taken place, whether through abrasion or accumulation being unknown. The inner surface of the negative was now covered by a rough and uneven polish. Although the reticular impression of the polish at Pos. 1 had once again become stronger and the polish as a whole had become more intense, there was no essential change in the last 50 minutes (pl. 4 : E, F ; pl. 5 : C). A clear surface formation of polish occurred dorsally as can be observed at Pos. 4 (pl. 5 : A). At a higher magnification the micropitting on the uneven and plastic surface can be distinctly seen (pl. 5 : B). The formation of a reticular pattern of polish is, in my experience, typical of harder organic worked materials (Pawlik, 1991). These, in contrast to softer ones such as hide or meat, do not yield so much to the unevenness of the surface structure of the utilized tool and therefore first come into contact with the higher areas of the microrelief, whereas softer materials are capable, at least at times, of conforming themselves to the tool surface.



Pl. 3. Horn Experimentation (E1/5-90). **A.** Position 1, polish after 15 min. of cutting. **B.** Detail of Position 1. **C.** Position 2, reticular polish formation after 45 min. of cutting. **D.** Detail of Position 2. **E.** Position 1 after 45 min. of cutting. **F.** Detail of Position 1.

The analysis of the edge damage with the stereomicroscope showed two characteristic areas along the dorsal surface of the working edge. At Zone A in the distal region, larger, flat negatives run parallel to the edge, some dorsal and some ventral (pl. 5 : D). At Zone B on the dorsal surface of the edge, there was a 4.5 mm long row of regularly shaped flat negatives with a « second edge row » (Vaughan, 1981) directly along the edge (pl. 5 : E). The « second edge row » was formed by small, regular negatives whose form could not be determined, although some have step and hinge distal forms. At Zone B ventral there were only a few individual scars with « shallaw

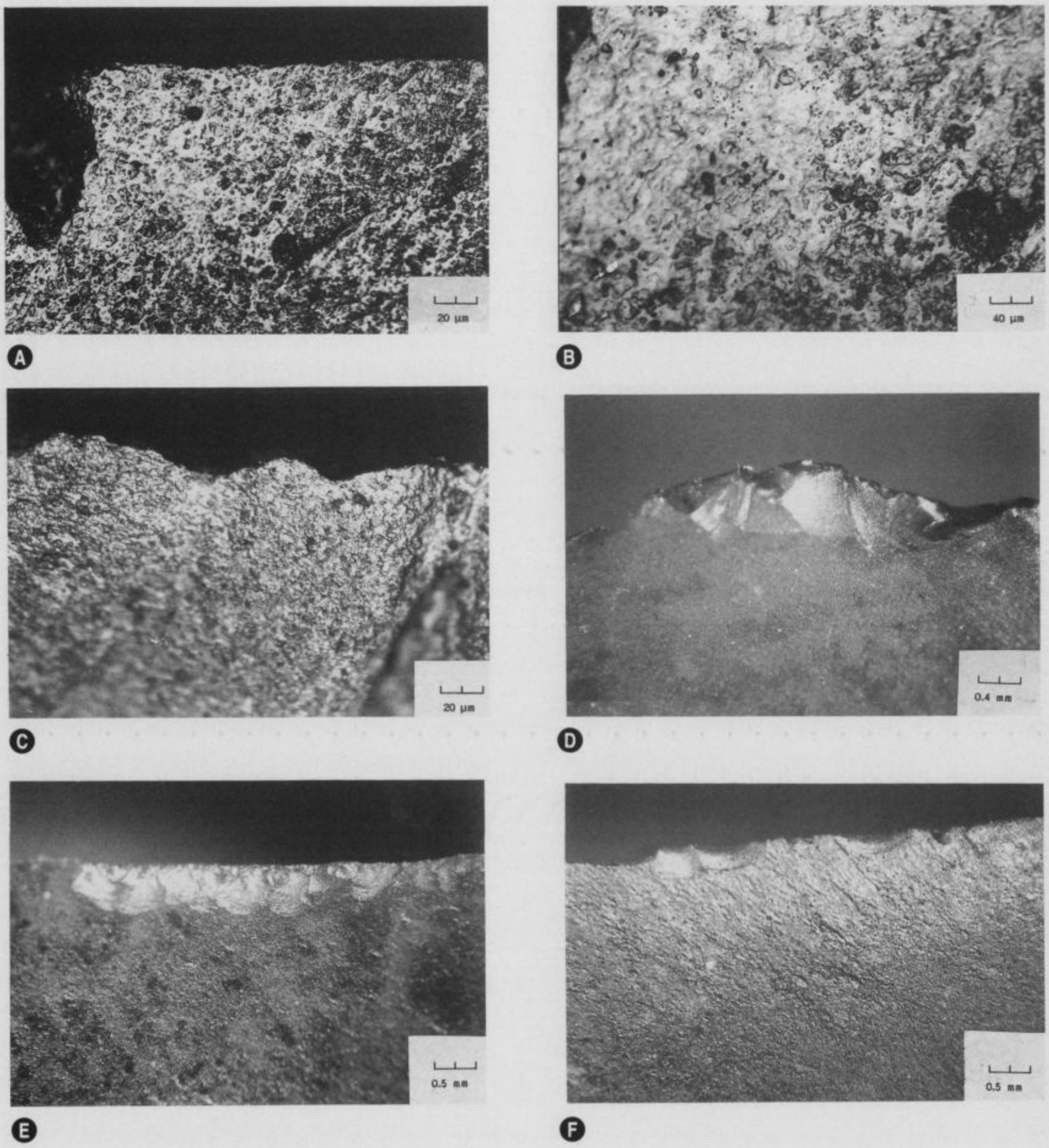


Pl. 4. Horn Experimentation (E1/5-90). **A.** Position 3, polish bevel. **B.** Detail of Position 3. **C.** Position 4, faint edge rounding. **D.** Position 4, view of the inner surface. **E.** Position 1 after 95 min. of cutting. **F.** Detail of Position 1.

break » (Vaughan, 1985 : 21) proximal sections and distal feather and step forms (pl. 5 : F).

Use-Wear Traces from Transverse Motions

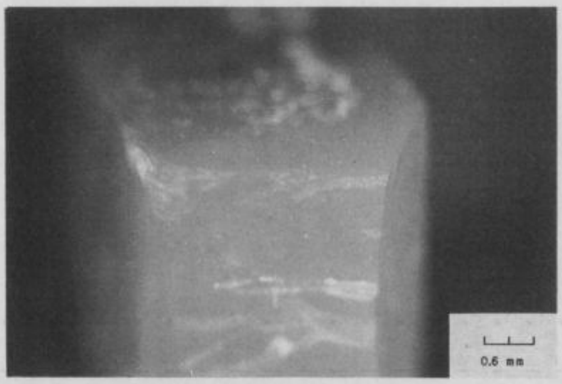
After 15 minutes of use, isolated spots of use-wear polish ca. 50 µm across could be observed on higher areas of the otherwise unaltered edge of the ventral scraper surface. These spots of polish had smooth surfaces, but were plastically convex with very vague striations which could not be resolved with the camera (pl. 6 : I - Pos. 1). After another 15 minutes, no changes could be observed at Position 1, however the polish spots along the scraper edge had increased in number. In addition,



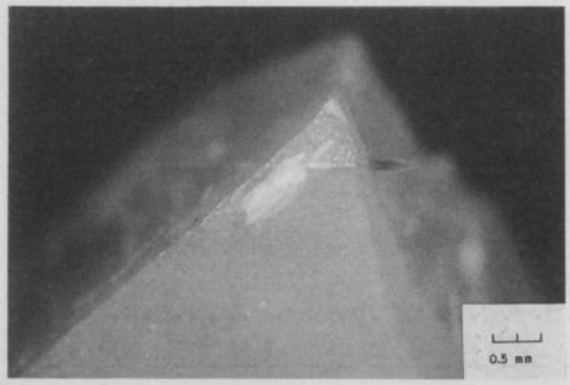
Pl. 5. Horn Experimentation (E1/5-90). **A.** Position 4 after 95 min. of cutting. **B.** Detail of Position 4, undulating pitted surface texture. **C.** Position 3 after 95 min. of cutting. **D.** Zone A. **E.** Zone B, ventral. **F.** Zone B, dorsal.

spots of polish also occurred on the inner surface near the edge, *e. g.* at Position 2 (pl. 6 : J - Pos. 2), 0.5 - 2 mm from the edge. Characteristic of these small spots of polish was a highly reflective surface, a clear delimitation from the neighboring surface, diffuse striations running in the direction of the motion, few depressions within the polish surface and a plastic appearance. At the zenith of the scraper cap in the region of Zone A, a bevel-like, but still unconnected weak edge polish had begun to form (pl. 6 : H).

In comparison to the cutting edge described above, the polish surface had no clearly recognizable micropitting, although similar diffuse depressions could be observed. Neither was there any formation of a reticular pattern, which was cer-



A



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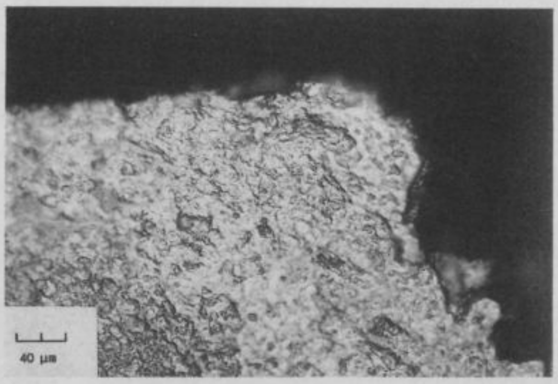
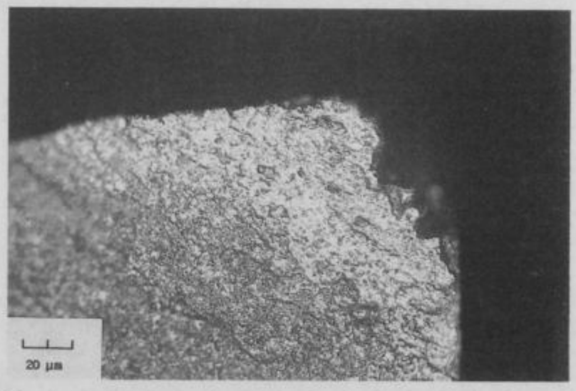
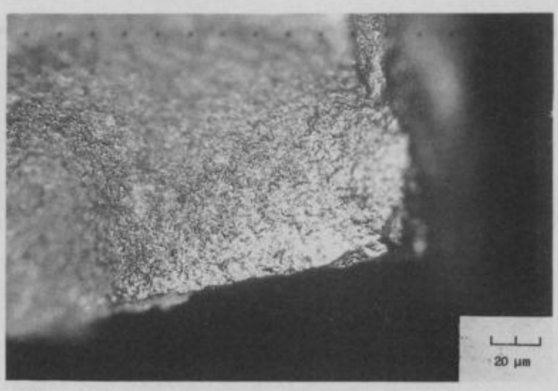


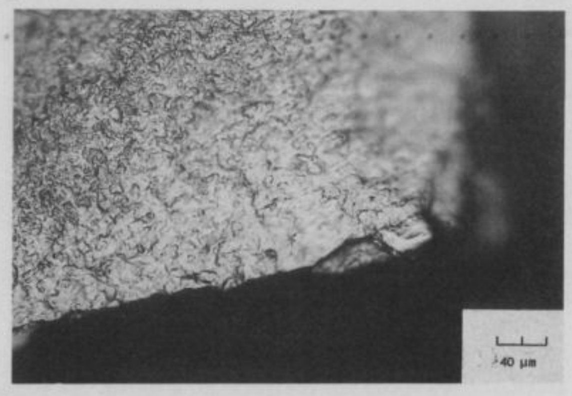
C



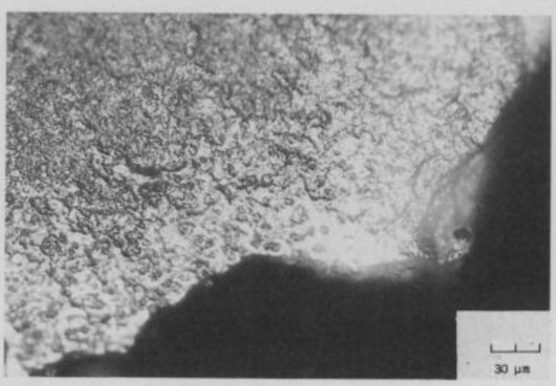
D



E



F



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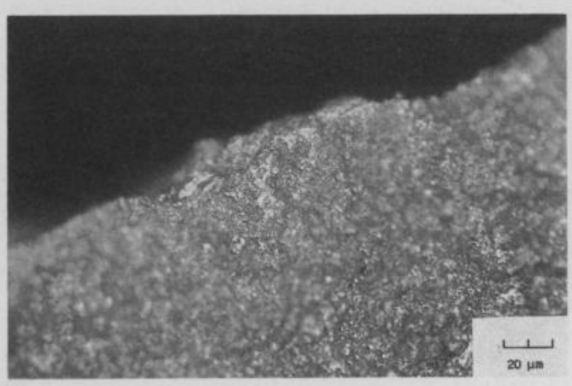

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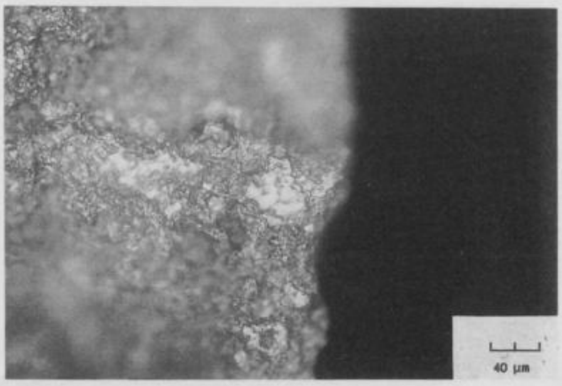
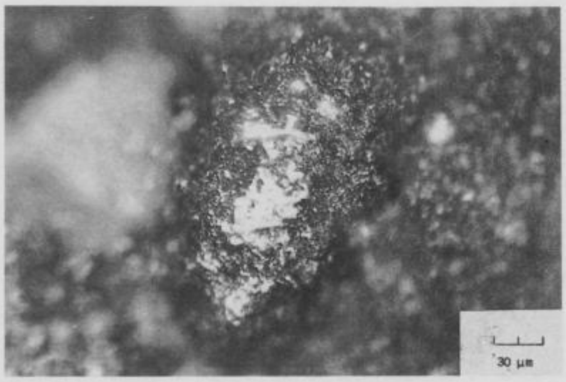




I J

Pl. 6. Horn Experimentation (E3/7-90). **A.** Burin bit. **B.** Burin bit, ventral. **C.** Postion 1. **D.** Detail of postion 1. **E.** Position 2. **F.** Detail of position 2. **G.** Position 3. **H.** Zone A, beginning of polish bevel formation. **I.** Position 1. **J.** Position 2, highly reflective spots of polish with vague striations.

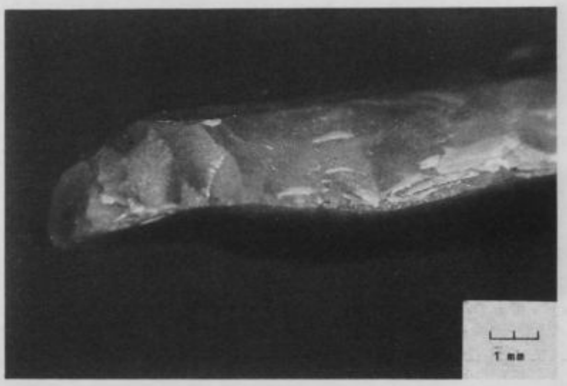
tainly due to the considerably more limited contact zone between the worked material and the tool. The dorsal scraper cap was, as expected, very difficult to analyze. In so far as this was possible, no polish was discovered on the surfaces of the negatives. The 11 minute activity with the lateral edge left, at the very most, only a somewhat higher reflectivity of the surface, but no observable polish.

Use-wear traces on the burin (E3/7-90) occurred mostly near the bit. A very sharp dividing line between the untouched inner surface and the polish could be seen on the dorsal surface. Together with the edges it formed an isosceles triangle, a clear indicator of the direction of the working angle of the burin (pl. 6 : C, D - Pos. 1). On the ventral surface, the region of the bit was too fractured to allow such a distinct development form. The polish was similar to that on the scraper, there were almost no micropits. On the burin facet itself, towards the dorsal surface (pl. 6 : E, F) and towards the ventral surface (pl. 6 : G), an extensively linked and very brightly reflective polish occurred on the edges. Striations were missing completely, although the general impression was linear. Once again, the clear delimitation to the inner surface is striking (pl. 6 : E, F, G). Although this tool was held very firmly and much pressure was applied, no traces of prehension could be observed. At the very most there was an increase in « optical noise » in comparison with the fresh flint surface.

Under the stereomicroscope, a continuous line of very small and irregularly formed scar negatives could be seen along the bit. Most of the negatives lie on the burin facet, the contact surface during the second part of the task. It is interesting that the ventral part of the bit, in contrast to the dorsal part, has a diagonal line of scars although during the engraving with the narrow section of the burin facet the dorsal part was doing the shaving (pl. 6 : A, B).

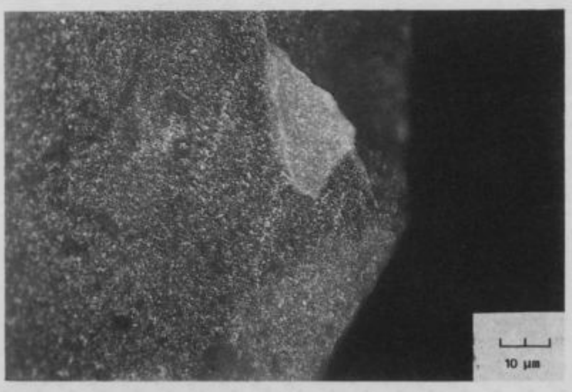
Use-Wear Traces from Rotating Motions

The most important characteristic of the use-wear traces on the borer (E4/7-90) was the different development of the polish on the dorsal and ventral surfaces. At Position 1, directly adjacent (ventral) to the tip, polish could be observed running linearly in the direction of the rotation. In contrast to the previously described polishes it had clear striations. The components of the linear polish were incompletely connected with each other. Individually they appeared plastic, giving a smooth to lightly wavey impression. They were without micropits or crater-like depressions and were slightly less reflective than the other polishes described (pl. 7 : C, D). Otherwise, a polish in the initial stage of development with somewhat brighter reflection could be seen ventrally along the cutting edge. There was also a clear formation of polish immediately adjacent to the tip on the dorsal surface. This, however, was a brightly reflective polish with a reticular pattern distribution on the narrow ridge surface at Pos. 2. Short, vaguely visible



A

B



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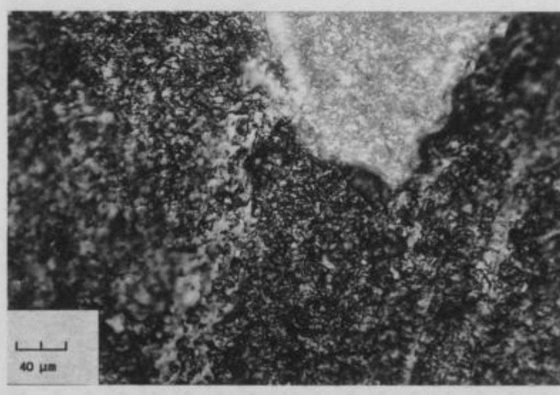

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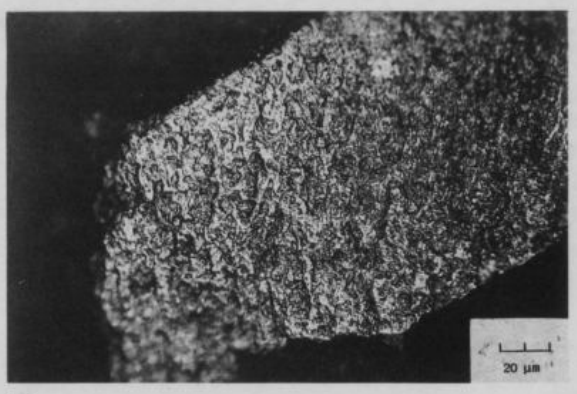

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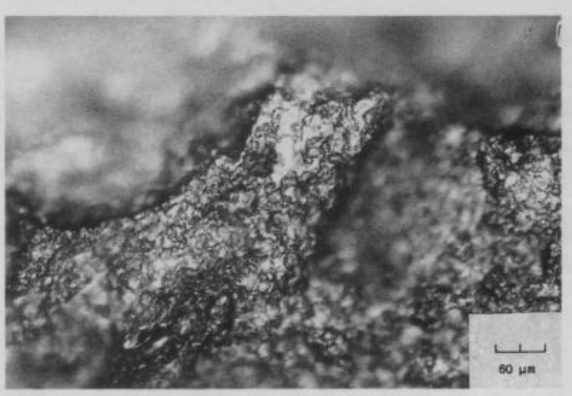

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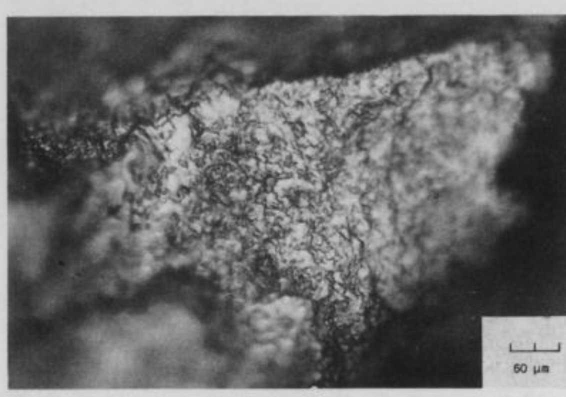

H

striations (ca. 10 µm long) occurred in the polish, but regular micropits were missing (pl. 7 : E, F).

The retouched edge sections were very heavily fractured. Weak traces of polish could only be seen there occasionally, mostly on the ridges between the negatives, *e. g.* Pos. 3 (pl. 7 : G), and on the borer tip (pl. 7 : H - Pos. 4). They were characterized by numerous fine striations running in the direction of the rotation.

The retouch negatives had so many different types of micro-scars that an analysis of possible edge damage on the dorsal surface with the stereomicroscope was not worthwhile (pl. 7 : A, B). On the ventral surface no edge damage was observed.

Conclusion

Working horn with longitudinal, transverse and rotating motions leaves recognizable use-wear polishes on stone tools. Characteristic of these are the formation of reticular patterns of polish in the area of contact with the worked material and a sharply delimited border between the polish and the interior surface. The polishes are brightly reflective and can be clearly differentiated from the neighboring surface of the tool. The polish structure is built up of individual spots, which are more or less intensively connected. Although the individual spots appear to be smooth and either flat or lightly plastic, the impression on the whole is more rough and wrinkled. There are also some irregularly shaped crater-like depressions in the surface of the polish. Longitudinal motions leave a micropitting of the polish with small holes less than 1 µm across. These micropits are missing almost completely on tools used in transverse motions. Clearly defined striations almost never occur, although rarely there are diffuse, relatively short ones. As a rule, working horn tends to lead to the formation of polish bevels less often than the working of harder materials such as bone, antler, ivory or wood. In the few cases where a polish bevel could be detected (E1/5-90), it was only temporary and disappeared almost completely as the work progressed.

Signs of wear were limited on the horn working tools. A partial rounding of the working edge could be observed on the tool (E1/5-90) used for cutting. It is of special interest that longitudinal motions produced a « second edge row » of scars normally associated with the working of harder materials, *e. g.* bones, antler, wood (Vaughan, 1981 : 113 ; 1985 : 22-23, 142-145). Engraving with the burin left limited scarring restricted to a narrow band along the burin bit. In contrast, no edge damage could be observed on the ventral surface of the scraper or borer.

Even after a very mild cleaning, the working of horn left no detectable residues on the tool surfaces. These would seldom be preserved in archeological contexts.

The attempt to work dry horn was very ineffective and quickly dulled the tool edge. The knowledge that adding a liquid lubricant makes it easier to work all harder materials is a very simple empirical experience, which one can assume that early man learned very early, even if archeological evidence is difficult to obtain.

The use-wear polishes produced by working horn can be morphologically ordered into the group of harder organic materials (Pawlik, 1991). The group includes polishes from working wood, bone, teeth and antler, but also ivory which has additional special attributes. The ability to differentiate between these worked materials on experimental tools and even more so on archeological artefacts is very limited or perhaps impossible. They do, however, have group specific attributes which separate them from other groups, *e. g.* hard inorganic materials (Pawlik, 1991). One of these attributes, which is especially pronounced in horn polish, is the formation of reticular patterns of polish. Other attributes are polish bevels on the used edges and a smooth plastic texture on developed polish surfaces. Polish bevels do form during the working of horn at times, even if they disappear as the work progresses. The individual spots of horn polish have the typical plastic surface texture, although the total picture appears more wrinkled.

In contrast to Plisson's (1985 : 59) observations, use-wear traces from working horn occurred more

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Pl. 7. A. Borer tip. **B.** Borer tip. **C.** Position 1, linear polish and striations. **D.** Detail of position 1. **E.** Position 2, reticular polish on dorsal ridge. **F.** Detail of position 2. **G.** Position 3, dorsal polish. **H.** Position 4, dorsal polish.

frequently and fell into the range of hard materials. Horn cannot be excluded as a possible worked material in microscopic use-wear analyses of lithic artefacts and must be included in group determinations of hard materials, if specific materials are named at all. At the present stage of research, however, it appears to be more appropriate not to always give detailed worked material reconstructions of archeological artefacts, but in questionable cases to be content with group determinations as the maximum possible material-specific assertion.

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Bibliography

HODGES (H.), 1964.– *Artifacts. An Introduction to Early Materials and Technology.* London, John Baker.

OWEN (L. R.), UNRATH (G.), (Ed.), 1986.– *Technical Aspects of Microwear Studies on Stone Tools.* Tübingen, Early Man News 9.10.11.

OWEN (L. R.), 1992.– Materials worked by Hunter and Gatherer Groups of Northern North America. Implications for Use-Wear Analysis. *This Volume.*

PAWLIK (A.), 1991.– *Experimente an einigen gebräuchlichen Werkstoffen der paläolithischen Kleinkunst und die Funktionsanalyse der verwendeten Steingeräte.* Master's Thesis, Institut für Urgeschichte, Universität Tübingen.

PLISSON (H.), 1985.– Étude fonctionnelle des outillages lithiques préhistoriques par l'analyse des micro-usures ; recherche méthodologique et archéologique. Thèse N. D., Université de Paris I.

UNRATH (G.), OWEN (L. R.), VAN GIJN (A.), MOSS (E. H.), PLISSON (H.), VAUGHAN (P.), 1986.– An Evaluation of Microwear Studies : A Multi-Analyst Approach. *In* : L. Owen, G. Unrath (Ed.), *Technical Aspects of Microwear Studies on Stone Tools.* Tübingen, Early Man News 9.10.11, p. 117-176.

VAUGHAN (P.), 1981.– *Lithic Microwear Experimentation and the Functional Analysis of a Lower Magdalenian Stone Tool Assemblage.* Ph.D. Dissertation, Department of Anthropology, University of Arizona Press, Tucson.

VAUGHAN (P.), 1985.– Use-Wear Analysis of Flaked Stone Tools. Tucson, University of Arizona Press.