Bull. Tohoku Univ. Museum, No. 16, pp. 69–86, 2017

Standard use-wear chart of TUMRT (3): Microwear Polish (1)

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INTRODUCTION

The present paper is the third part of the results of microwear analysis by Tohoku University Microwear Research Team (TUMRT). It is an initial part of explanation of standard identification criteria of a category of use-wear traces, that is, microwear polish. The part 1 and part 2 of TUMRT standard were published in the Bulletin of the Tohoku University Museum, No. 13 (Akoshima and Hong 2014), and also No. 15 (Akoshima and Hong 2016). The present article is to be utilized with part 1 and 2, which will soon be available through the Tohoku University Library website (TOURS). Part 1 and 2 explain analytical framework of microflaking (microchipping) analysis by TUMRT, typical patterns of microflaking scar appearance, variables in experimental control, and the expanded range of micro-photographs to cover various different appearances of microflaking scar patterns. In part 2, we also explained in detail the method of analyzing the actual wide range of microflaking varieties by counting frequencies and classifying attributes of chipping scars, for the basis of statistical analysis of flaking scar variability, as was already summary published in Japanese (Akoshima 1981) and English (Akoshima 1987).

Here as part 3, we review fundamental classification systems of microwear polish that have been called as Tohoku classification since 1981 and were actually widely used by many Japanese lithic use-wear analysts. The polish types are presented with typical micro-photographs and their range of appearances are shown with a number of sample micro images. In the present volume, images of microwear polish produced with soft contact materials are shown here. Those polish images with medium and hard worked materials will be presented in our future report.

EXPERIMENTAL DATABASE

The present paper continues to introduce essential criteria of micro-wear interpretation accumulated by TUMRT since 1976. The team was initiated by the late Prof. Chosuke Serizawa and has been active up to the present (for its history, e.g. Akoshima 2008). This is to be the third of a series of presentations resulting from the TUMRT inferential criteria.

The database presented here is a part of the first series of TUMRT project directed by Serizawa. Microwear polish data were analyzed by Kajiwara and Akoshima (Kajiwara and Akoshima 1981, Akoshima 1989) and the data have been utilized by TUMRT members since then. Micro-photographs were color printed and served on file at the Department of Archaeology, Faculty of Arts and Letters.

The procedure of photographic data presentation in the present publication is basically the same as our previous reports (Akoshima and Hong 2014, 2016), so only short descriptions are repeated here for readers' reference. The paper photo-micrographs in the TUMRT file were scanned at 1200 dpi and color digitized. For the present report, representative images were chosen for presentation of "microwear polish types" for polish type A to type F2 (Figure 1 to Figure 4). The wider range of microwear polish patterns are shown for better recognition of overall wear varieties. By referring the typical polish type photos with image data from various worked materials (Figure 5 to Figure 12 for soft contact materials), the range of microwear polish patterns are roughly knowable.

From Figure 5 on, experimental micro-photographs are arranged in the order from working soft materials (meat, rawhide, leather, soft plant) to medium (wood, bamboo), to hard materials (bone, antler). The latter two categories will be reserved for our next report, though. Within the category of similar hardness, they are sub-divided and arranged by the method of use, from parallel motions (cutting, sawing) to perpendicular motions (scraping, whittling).

The main raw materials in our experimental project for polish analysis were the shale collected from the riverbed of the Mogami River in Sagae City, Yamagata Prefecture. It should be noted that the "shale" in the Japanese rock type terminology for lithic analysis denotes a sort of fine grained sedimentary rock with breaking feature of conchoidal fracture. The rock type was in wide use throughout prehistory in northeastern part of the Honshu Island of Japan (Tohoku District).

The micro-photographs are not presented with a scale bar for fixed length, but the size of photographs are kept constant (ca.700 microns from right to left of the photo at the case of 200 X). Photos with no magnification number were taken at 200 X when being observed. Photos with the number of “400 X” at the end of caption were taken at 400 X when being observed (the width of photo is thus ca.350 microns).

The order of presenting photographic data from Figure 5 on, is as follows. Basically, they are arranged so that the general patterns of microwear polish are recognized according to the category of contact materials and the kind of motion, as in Kajiwara and Akoshima (1981). Namely, the Figures are captioned with the category of worked materials and working edge motions. At the end of the caption, identified polish type(s) and the experimental specimen number are shown. Microwear polish often appears as combination of multiple types (for example, D1 type surrounded by F1 type), and in those cases, type names are combined (for the example, D1F1, and so on).

They are shown in the following order (the same order as Akoshima and Hong 2014, 2016). It is presented here again for quick reference of the reader. We plan to publish micropolish photos from worked materials 4.1 to 9.3 (medium and hard) in our next report.

1. Meat, 1.1 cattle (beef), 1.2 pig (pork), 1.3 lamb (mutton), 1.4 duck, 1.5 chicken
2. Plant, 2.1 grass, 2.2 wheat crop, 2.3 rice crop, 2.4 reed, 2.5 pampas grass
3. Hide, 3.1 rawhide, 3.2 half dried hide, 3.3 dry hide
4. Wood, 4.1 paulownia, 4.2 cedar, 4.3 pine, 4.4 alder, 4.5 zelkova, 4.6 others
5. Bamboo
6. Gourd
7. Shell
8. Bone, 8.1 raw, fresh, 8.2 wet and boiled, 8.3 boiled
9. Antler, 9.1 soaked, 9.2 dry, 9.3 others

For the third digit of each photo caption number, the type of motion in use is indicated as follows.

Longitudinal, -1 cutting, -2 sawing

Transversal, -3 whittling, -4 scraping

Varied, -5 chopping, -6 butchering

Incising, -7 graving

Micro-photographs were all taken using a film camera attachment (before 2003) to the binocular metallurgical microscope of Olympus BHM system. The magnification shown is at the time of photography. The reversal 35mm color slides were printed and used as references for micropolish identification for many years at Tohoku University Archaeological Laboratory. They were, in a sense, “standard polish chart” for Japanese lithic use-wear analysts. We think it is meaningful for this time to publicize the standard photos.

HISTORICAL REVIEW OF POLISH IDENTIFICATION

Since the first discovery by Keeley (Keeley 1977) that various microwear polishes reflect the kind of worked materials, the fact of correlation between the contact materials and polish attributes was widely admitted among the scientific circle of lithic analysts. Hence the way of calling polish varieties with the name of representative worked materials has become a world standard up to the present. The names “wood polish”, “bone polish”, “dry hide polish” and so on bring us some clear imagination in our mind, at least in case of use-wear analysts. However, from the very beginning of this discovery, Keeley already recognized that a large variety of polish appearance did exist among the edges of utilized stone tools made of European flint. So, the nomenclature of polish names originally entailed some discrepancy in that the same worked materials do produce a considerable range of differently appeared microwear polish.

Our team, too, noticed the fact that the polish was variable even from the same worked materials by conducting independent sets of controlled experimental programs. We used replicative Japanese lithic raw materials, including “shale” and chert, as well as European flint. The European flint was brought to Tohoku University from Denmark by the late Prof. Akira Matsui of Nara National Institute of Cultural Properties (at that time, a graduate student of Tohoku University). Dr. Kazuo Aoyama and TUMRT members conducted supplementary experiments on flint at a later time. The first recognition of Japanese microwear polish came up during the final excavation of the Early Palaeolithic site of Hoshino, in Tochigi Prefecture in 1978. The excavation was directed by the late Prof. emeritus Chosuke Serizawa, with a government funding (KAKENHI). The history was introduced by Akoshima (2008), and the reader may refer to the episodes.

What is to be emphasized here is the research history in which our team attempted to carry out the so-called “scientific reproductivity” procedures. Kajiwara and Akoshima repeated experiments using the replicated shale tools and found that Japanese shale artifacts actually exhibited evident microwear polishes which were very similar to the published photo images by Keeley (1977). Additional experiments of chert and obsidian also reconfirmed the fact.

Accordingly, our team first described the appearances of microwear polishes with the title of the contact materials as Keeley did. Some documents remain on file at our Tohoku University Laboratory and there go the lines concerning polishes on shale as follows (Akoshima 1980, pp.89-91).

Characteristics of Polishes.

1) Wood polish (Plate numbers are omitted here).

A typical wood polish is bright and smooth. Inner and outer contrasts are high. Few pits are observed on polished area. It is smooth especially on elevated portions, and sometimes looks even slippery or domed. It first develops on elevated portions according to microtopography. But the depressions are not easily polished. Heavily polished area sometimes undulates, accompanying a kind of striation of “troughs and crests”.

Working bamboo and gourd produced similar type of polish, which can be included in wood polish. They are bright, smooth, with high contrast.

In some cases, wood polish is atypical with rugged or rough characteristics.

2) Corn gloss (“Nonwoody plant polish” according to Keeley).

The characteristics of corn gloss observed on our experimental flakes are almost nearly the same as those described by Witthoft (1967) and Keeley. It is very bright and smooth, shining even to the unaided eye. “Filled in” striations are observed running in the direction of activity. Polish covers elevated portions first and invades over the depressions. It looks like, as it were, the surface painted with viscous liquid. The contrast is extremely high. The fluid appearance of the affected area is quite distinctive. However, clear “comet shaped pits” were not observed on our experimental specimens.

3) Bone polish and antler polish.

Bone and antler often produce bright but rough polish. They are sometimes as bright as wood polish. The contrast is high. A lot of tiny pits in various shapes are found. The pitted surface gives battered appearances to the altered area. The pits are even found on very bright portions that were heavily polished. The heavily polished area that is usually the tip of the edge becomes smoother than the rest of affected area, but it can be distinguished from wood polish in that slightly polished area remains rough. Soaked antler often produces smoother bright polish than bone. Rugged polish is also produced by bone or antler working.

4) Meat polish.

The polish produced by working meat is usually very dull. Sometimes it is quite faint and hardly recorded on photographs. Contrast (both inner and outer) is very low. Polish is not necessarily restricted to the elevated portions of micro-topography. Depressions of the original surface are similarly affected by polish. Meat polish sometimes has “greasy” luster which looks like as it were, oiled or lubricated surface. Tiny pits are not found. Sometimes rugged polish is also found.

5) Hide polish.

Hide polish of rawhide sometimes resembles meat polish: dull, low contrast, greasy luster. But various polishes are produced in case of hide. There are both bright and dull, high contrast and low contrast, and rugged. Pits are sometimes found. The surface becomes heavily “pitted” when soil is involved in the experiment. Both smooth and rough polish developed, but in some cases, elevated portions became smoother.

6) Soil polish and natural polish.

There are polish types characteristic of soil involvements and developments on naturally patinated surface. (In hindsight, these types (Type X and Type Y) were initial recognition of PDSM (post depositional surface modification) and “soil sheen” phenomena.)

As our team was convinced that these polish characters were almost identical to the polishes produced on European flint and described by Keeley (1977), Akoshima brought photograph prints to SAA (Society for American Archaeology) held in San Diego, California in April 1981 to discuss with Dr. Keeley himself. Our conclusion was that the data on the Japanese shale would support his hypothesis of common polish characteristics among various CCS rocks.

The reason why we reiterate the original description is that the Tohoku polish classification basically followed the first recognition of polish on shale, but that the “in-exclusiveness” of polish and contact material correlation turned out to be too large to retain the original “contact material nomenclature” (Serizawa, Kajiwara, Akoshima 1982). The fact of relative correlation was also graphically included in French explanation (Akoshima 1995).

DESCRIPTION OF MICROWEAR POLISH TYPES

Actual appearances of microwear polish are rich in variety even along one working edge, but there are portions which are evaluated as representing typical types. TUMRT originally classified the polishes into 11 types (Kajiwara and Akoshima 1981). The classification was recognized as standard types among many microwear analysts in Japan, and since very widely adopted and applied to actual artifacts nationwide. However, the original presentation of polish types was not necessarily exhaustive in that only representative sample pictures were published. Actually, personal communications for experimental specimens with team members spread the criteria in the country. The lithic raw materials were limited to “shale” for early programs, but other lithic materials such as chert, obsidian, rhyolite and other CCS (crypto-crystalline silica materials) were also included as well as European flint. It was revealed that most lithic raw materials developed basically similar types of microwear polish.

The Tohoku classification was briefly published in English in a report of the Mill Iron site, Montana, USA (Akoshima and Frison 1996). In French language, the classification and typical photo images of types were published in the excavation and research report of a Magdalenian rock-shelter site of Abri Dufaure compiled by Straus (Akoshima 1995).

It is true that great difficulties exist in explaining the characteristics of observed and/or photo images by verbal words. We found that language differences (English and Japanese) also prevent from precisely translating the subtle nuances of description. For example, the Japanese *“kadobatta”* does not equal to “angular” or “rugged”. We chose to present as many actual microphotos as possible instead of cumbersome explanation sentences. Due to some limitations, we divide the photo contents into 2 separate articles, this report and the next. We apologize for the inconveniences but we hope the reader would understand.

The following is supplementary to explanation of polish characteristics. They were influenced by Keeley (1977, 1980), but based on the TUMRT initial series of experimental results (Akoshima 1980).

“Bright” and “dull” are used in terms of “brightness” of polish. It relates to the reflection of light.

“Contrast” is used in terms of the difference of “brightness” between two areas. “Inner contrast” means the difference of brightness between brighter part and duller part of polished area. “Outer contrast” means the difference of brightness between polished area and unaltered area neighboring the polished area.

“Smooth” and “rough” are used in terms of the evenness of the texture of polished area.

“Rugged” means a distinctive appearance of polished area. The surface is very uneven, preserving the original micro-topography, shining with very fine-grained difference of brightness, with some “greasy” luster. It looks like, as it were, a boiling liquid of high viscosity.

“Coarse” and “fine-grained” is used in terms of the surface texture of shale.

“Pitted” is used when these “pits” do not seem to be the original depressions of micro-topography, but seem to be plucked off pits.

The explanation (Akoshima 1995, Akoshima and Frison 1996) is summarized here. The word order is approximately: contrast and texture, extension, other characteristics, and related worked materials (in the parenthesis, less common but related materials).

Type A [Figure 1(1), (2), (3)].
Very bright and smooth. Covers wide area rather evenly. “Filled-in” striations, “comet-shaped” pits; when underdeveloped, resembles Type B. Non-woody plants, (bamboo).

Type B [Figure 1(4), (5), (6)]
Bright and smooth. Round and “domed” appearance. well-defined patches develop on high portions, clear striations. Wood, bamboo, (bone, non-woody plants).

Type C [Figure 2(1)]
Relatively bright but rough. Covers wide area rather evenly with flat patches; patches are ill-defined. With numerous pits of various size/shape, depressions, striation; often surrounds Types D1 and D2. Sawing soaked antler (and bone).

Type D1 [Figure 2(2), (3), (4)]
Bright and smooth; very flat and lacks “roundness”; includes “melted snow” type. Flat polish patches are well-defined. Directional undulations often constitute wide striated features. Bone, antler, (wood).

Type D2 [Figure 2(5), (6)]
Bright but less smooth than D1. Polish patches are well-defined. Patch surface undulates with numerous parallel, sharp striations. Bone, antler, wood, (bamboo).

Type E1 [Figure 3(1), (2)]
Dull and relatively rough. Polish patches are small and confined. Numerous tiny pits and very minutely rugged (“rugose”); usually accompanies Types E2, F1, F2. Hide, meat, (wood).

Type E2 [Figure 3(3), (4), (5)]
Dull and relatively rough, “matte” texture. Patches are less confined and sometimes flat; when developed, patches grow and “roundness” increases. Numerous tiny pits and very minutely rugged (“rugose”); usually accompanies Types E1, F1, F2. Hide, meat.

Type F1 [Figure 3(6), Figure 4(1)]
Dull and rough, sometimes “greasy luster”. Patches are not well-defined; polish follows micro-topography (on both elevations and depressions). Coarse “rugged” appearance; And Type F1 often develops into Type D1 on antler/bone. Dry antler, bone, hide, meat, wood.

Type F2 [Figure 4(2), (3), (4)]
Very dull, weak. Polish follows micro-topography. Often accompanies other types. Generic polish, hide, meat, (wood, bone).

Type X (Kajiwara and Akoshima 1981, figure 3-18)
Dull, “battered” appearance. Extends widely. Very “rugged”; full of pits, depressions; striations everywhere. Soil (digging, etc.) or any other material in contact with soil.

Type Y (Kajiwara and Akoshima 1981, figure 3-19)
Relatively bright but no contrast (even brightness), variable texture. Entire surface is covered. Random striations; various pits. "Patination" polish, polish on naturally worn surface.

The Tohoku classification system has spread also through direct personal communications among lithic analysts. Independent experimental works by the analysts contributed to reliable inferential criteria. In Japan, the Palaeolithic period, the Jomon period, and the Yayoi period respectively have maintained their traditions of stone tool research. The scientific community was not so huge in the country and there were also networks through legal administration system of the cultural properties protection, including mandatory site excavation and site report publication and social circulation. The foci of the Palaeolithic period research included spatial distribution and human behavior, and those of the Yayoi period research included studies of agricultural equipments such as leaping knives.

Although the microwear analytical techniques were regarded as standard research procedure, there was a certain degree of skepticism about the objectivity of functional determination. The "Palaeolithic fake scandal" committed solely by Mr. Fujimura which was exposed on November 4, 2000 as a scoop of the Mainichi Shimbun newspaper seriously deepened this skepticism. In such a social atmosphere, the disciplinary organization of "the Society for Lithic Use-Wear Studies" headed by Dr. Midoshima and Dr. Harada launched a joint research project of use-wear analysis in 2003.

In the joint project, a communal experimental program was carried out to strengthen the methodological objectivity of use-wear analysis. One of the main themes has been the problem of polish classification and their attribute analysis. The final results of the joint project are in preparation for publication, so we cannot discuss the relations of the joint project and Tohoku University polish analysis here. Tohoku classification is "explanatory description", while the Society tactics is "attribute analytical characterization". We plan to discuss their similarities and differences the next time.

CONLULUSIONS

Microwear polish is a minute scale phenomenon of surface alteration, but its mechanism, that is, physical processes of formation is not clearly determined. There were theories of additive substance explanations as well as abrasive explanations (e.g., Yamada 1986, 1993), or complex combination of both. Our team has been in a position to morphologically observe and classify its wide variation and attempt to correlate the formal phenomena to actual functions of tool use.

Classification of microwear polish tends to ignore diversity. Each micro-polished working edge has individual characteristics that would not be accommodated into type classifications. In order to alleviate this missing feature of diversity, micro-photographs were repeatedly taken and compared. Of course these micro-photographs do not necessarily represent all the variation of surface morphology that occurred on the edge of flakes used in a particular work. However, within the framework of controlled experimental program of TUMRT, relationships between micro-polish identification and contact materials were clearly discovered.

The polish photo database presented here will serve for a means of fundamental pattern recognition of the category of use-wear which can be observable with a standard equipment of high magnification optical microscope. We very affirmatively keep the methodological position that each category of use-wear, namely micro-polish (or microwear polish), striation, micro-edge-damage (microflaking, e.g., Tringham et. al. 1974), and even macro-wear patterns which are often observable with a hand magnifier, has its own potential. We need to integrate various different categories of use-wear for a more reliable method of interpretation. Our fundamental direction is again based on the theoretical standpoint of the "middle range research" in the sense of Binford (1981, pp.21-30), where all the archaeological records as data are integrated together with data sets in actualistic situations such as experimental archaeology.

Microwear polish is often difficult to identify when heavy patination, or "post-depositional phenomena" affected the working edge of the tool. Another restriction of micro-polish is the quality of raw materials. Relatively coarse-grained lithic materials such as andesite, or extra-hard materials prevent from reliable identification of micro-polishes. In case of relatively soft but fine-grained materials such as rhyolite, or acidic volcanic rocks, surface alteration and abrasion of the edge often makes polish identification difficult. However, once polish types are identified, the inference of contact materials can be more detailed. We reiterate our conclusion (Akoshima and Hong, 2016) that all types of use-wear should be paid enough attention as long as they are observable along the working edge. Proper sets of equipment should be applied to observe the target use-wear traces. More problem oriented methodological thinking is fundamental for the establishment of standard procedures of use-wear analysis.

ACKNOWLEDGEMENT

Prof. Hiroshi Kajiwara of Tohoku Fukushi University actually conducted many of the replicative experiments together with the first author while he was at Tohoku

University. We are grateful to Prof. Atsushi Fujisawa of the Tohoku University Museum for recommending our publication in its Bulletin series. The database publication of this page size sometimes faces difficulties to find places to be accommodated. We hope that the Bulletin series will continue to publicize TUMRT research standards for basic reference purposes nationwide. Lastly, this article is a result of KAKENHI (Grant-in-aid for Scientific Research) by the Japanese government (JSPS), which was granted to Akoshima (2016, number 25370885).

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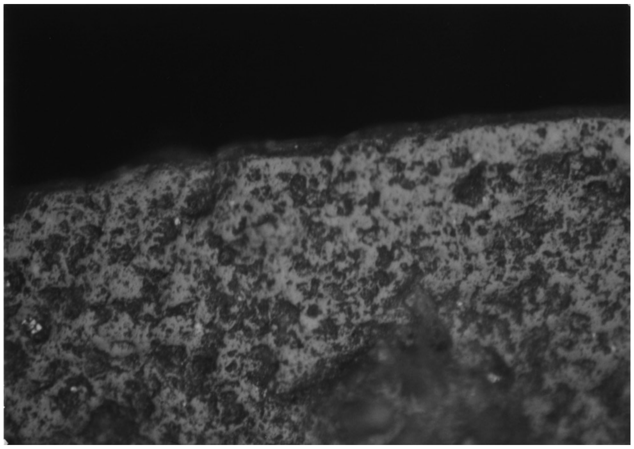
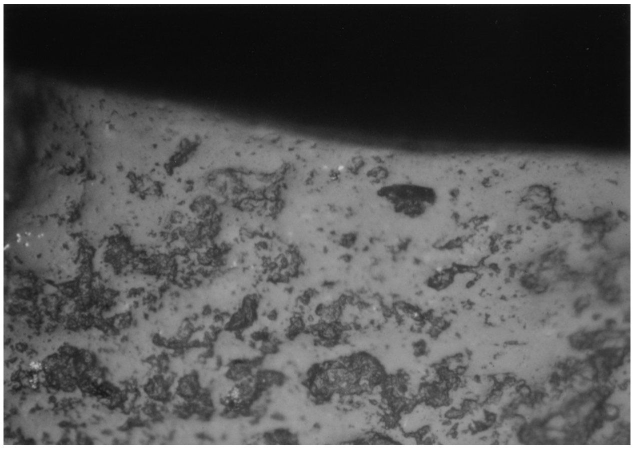
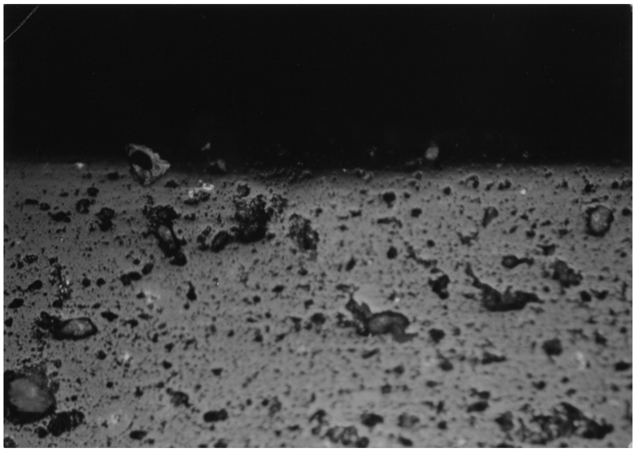


(1) polish type A. grass cut 2200st (SH140d)



(2) polish type A. grass cut 2200st (SH141) 400x



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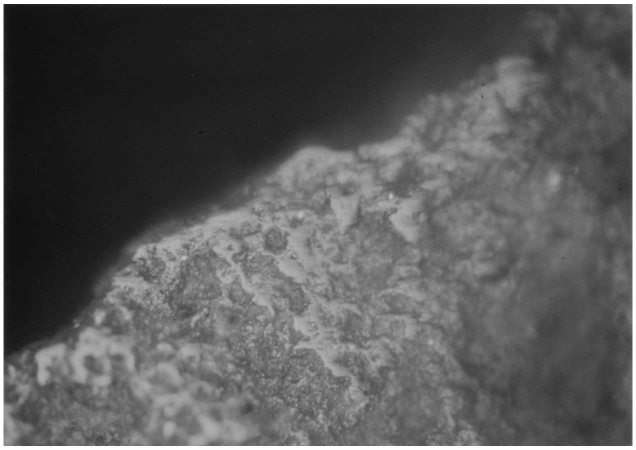
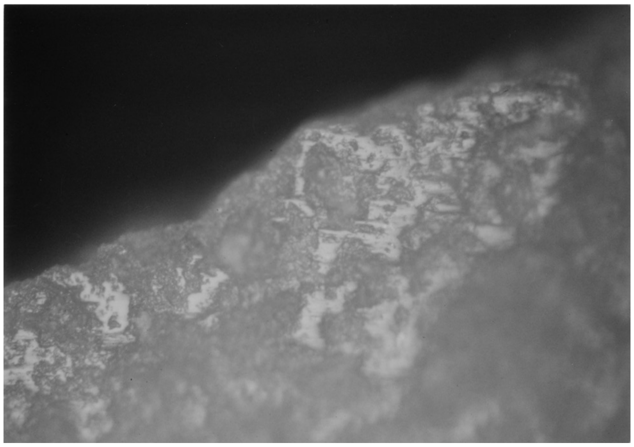
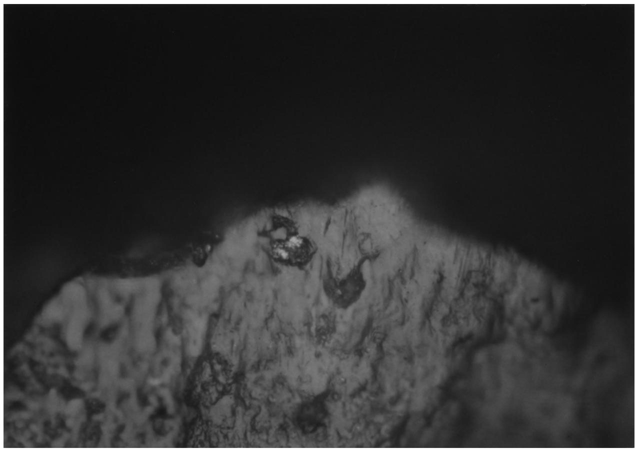


(4) polish type B. wood cut 4000st (SH103)

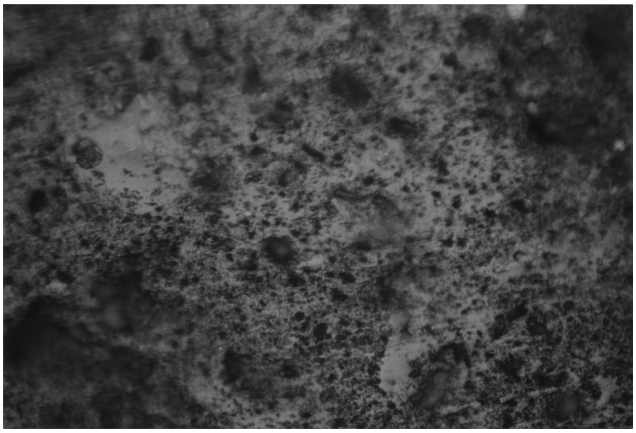


(5) polish type B. wood saw 5000st (SH49)



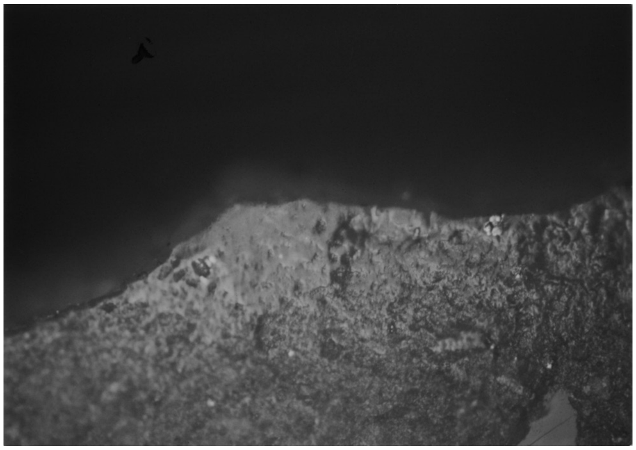
(6) polish type B. wood scrape 5000st (SH110) 400x

Figure 1. Experimental microwear polishes.

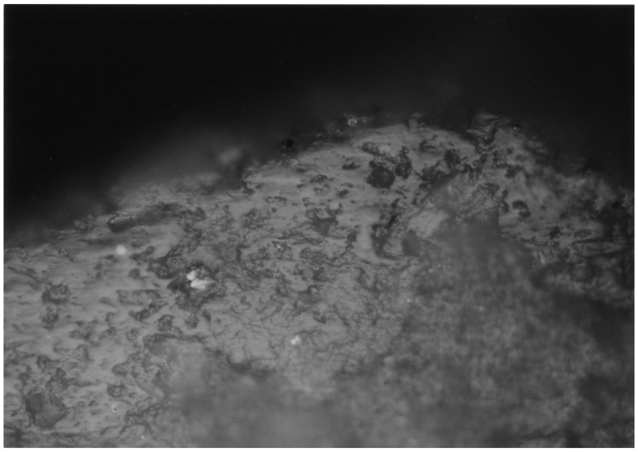


(1) polish type C. antler saw 4000st (SH47)

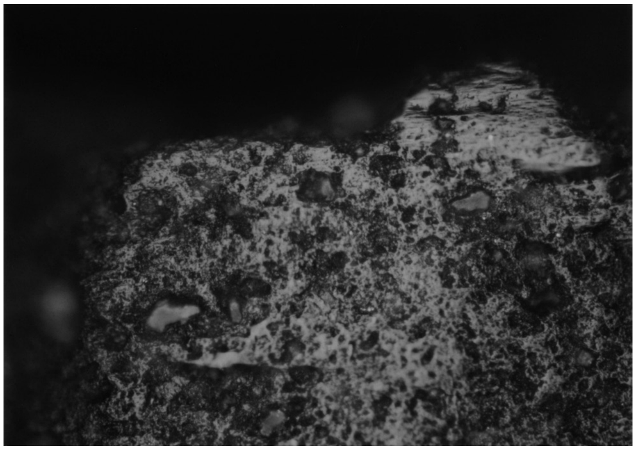
(2) polish type D1. bone scrape 1500st (SH93)



(3) polish type D1. bone scrape 1500st (SH93)



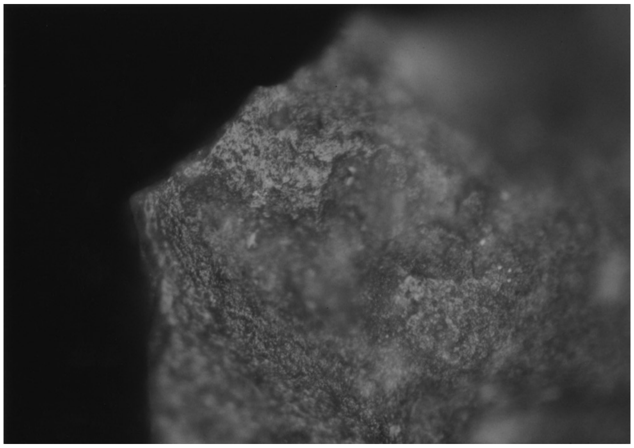
(4) polish type D1. antler cut 4000st (SH106) 400x



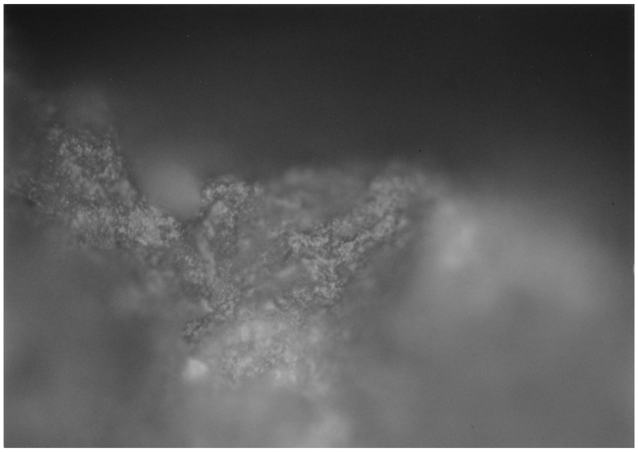
(5) polish type D2. bone saw 5000st (SH92)

(6) polish type D2. bone saw 5000st (SH92) 400x

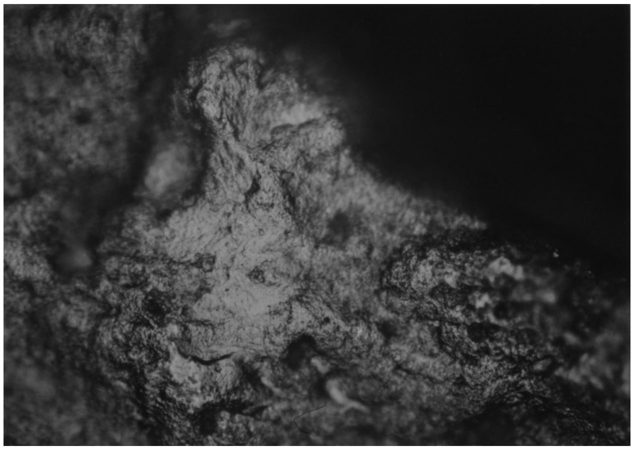
Figure 2. Experimental microwear polishes.



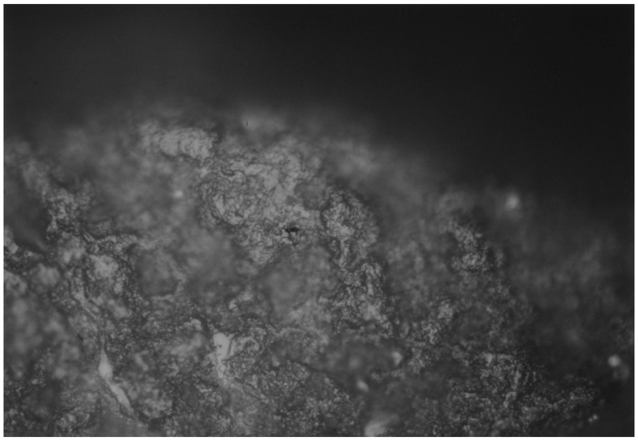
(1) polish type E1. hide cut 1000st (SH113)



(2) polish type E1. hide scrape 500st (SH132) 400x

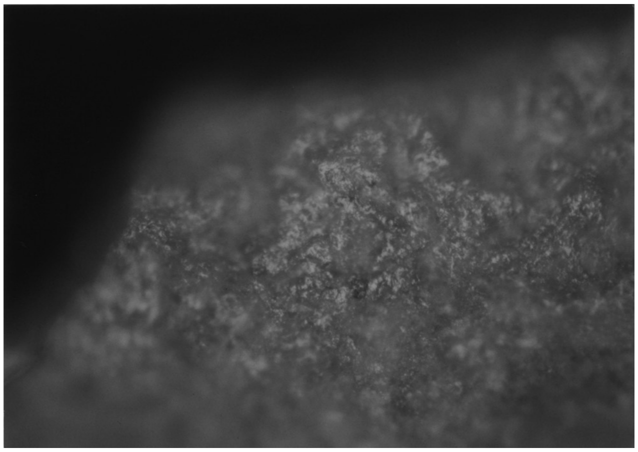


(3) polish type E2. hide scrape 2000st (SH35)



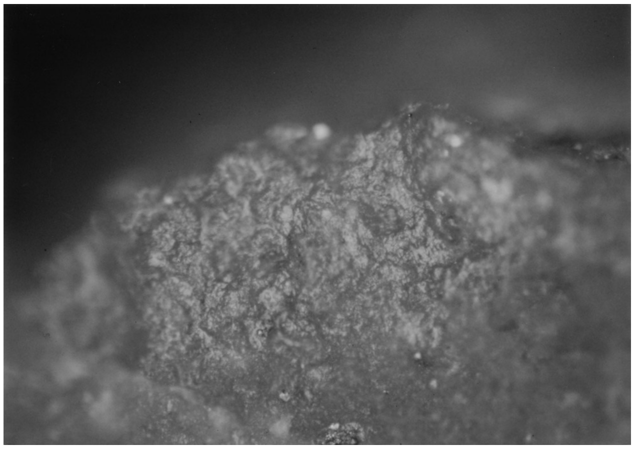
(4) polish type E2. hide scrape 10000st (SH28) 400x

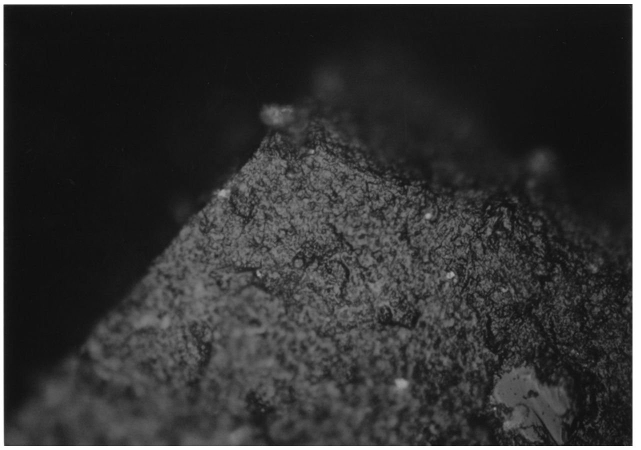
(5) polish type E2. hide saw 2000st (SH76)

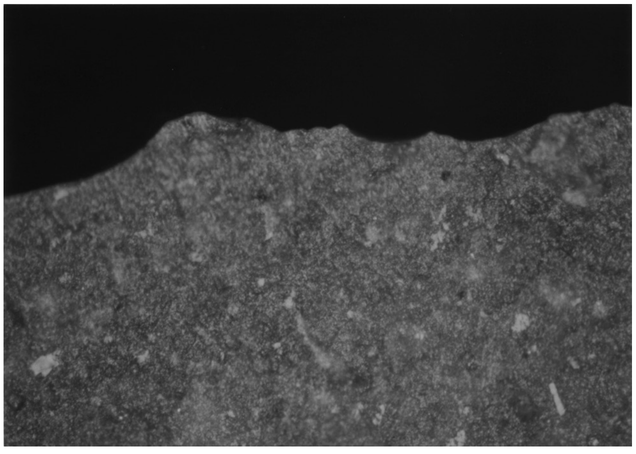


(6) polish type F1. bone whittle 1000st (SH19)

Figure 3. Experimental microwear polishes.


(1) polish type F1. antler 2000st (SH72) 400x


(2) polish type F2. meat cut 800st (SH26) 400x


(3) polish type F2. hide scrape 2000st (SH122)

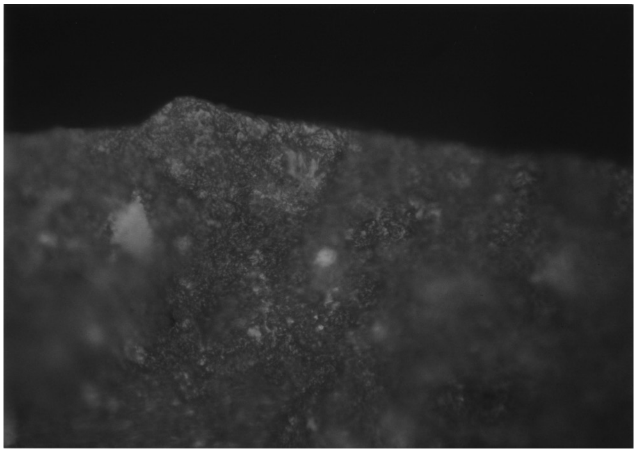
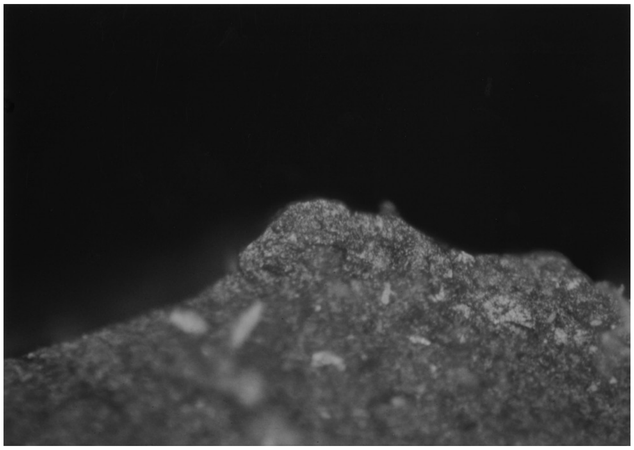
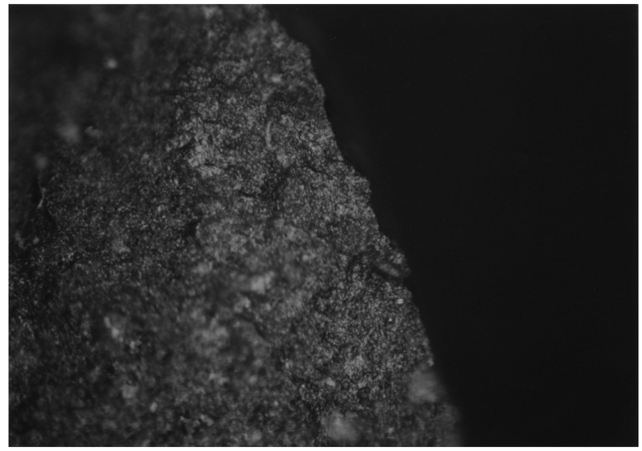

(4) polish type F2. hide scrape 2000st (SH112)

Figure 4. Experimental microwear polishes.

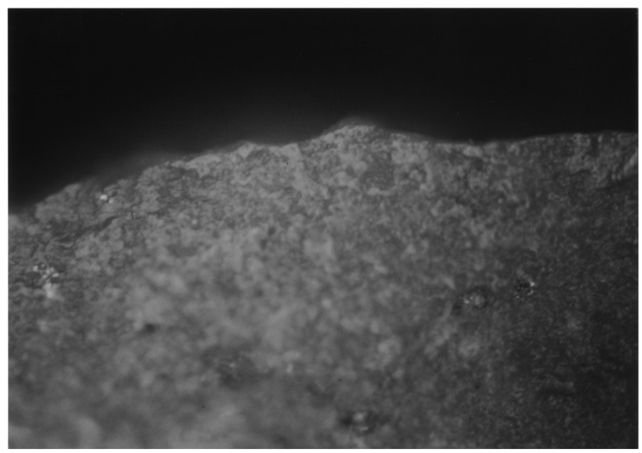


(1) 1.1-1. meat cut 800st. type F2E1. (SH26)

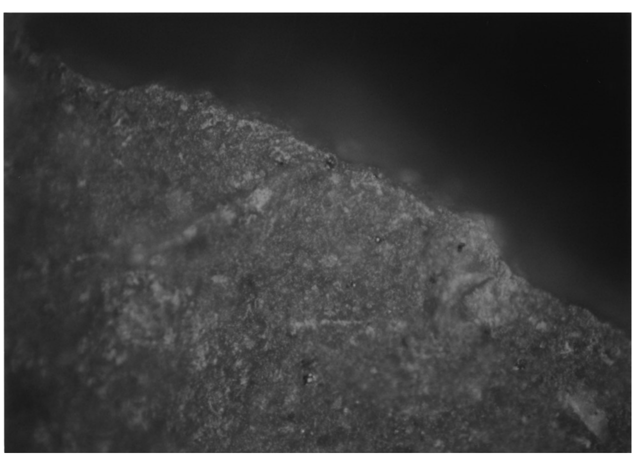


(2) 1.2-1. meat cut 1100st. type F2. (SH57)

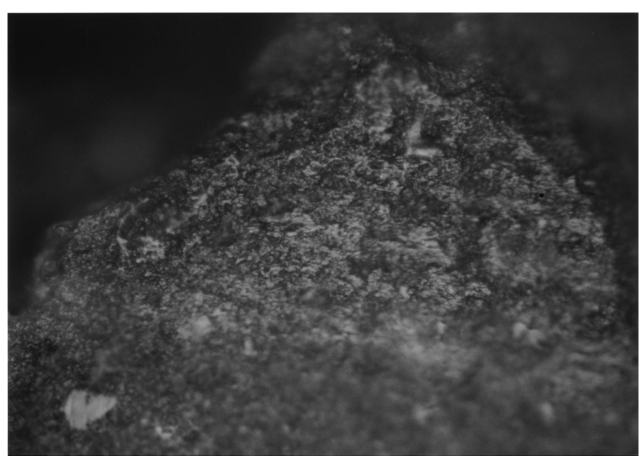
(3) 1.4-6. meat butcher. type E1D1. (SH107)



(4) 1.4-6. meat butcher. type E1. (SH103) 400x

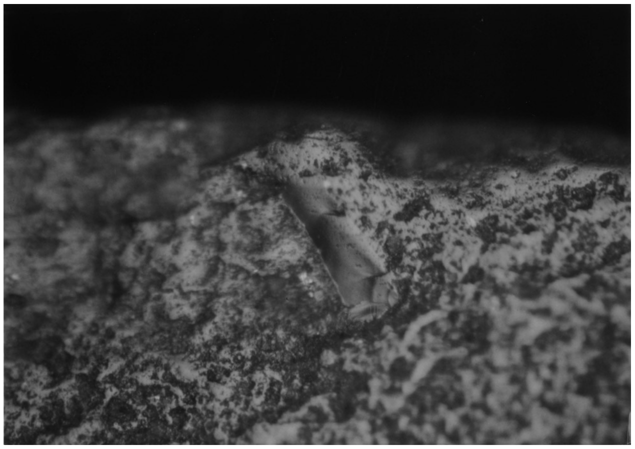


(5) 1.4-6. meat butcher. type E1 (SH108)

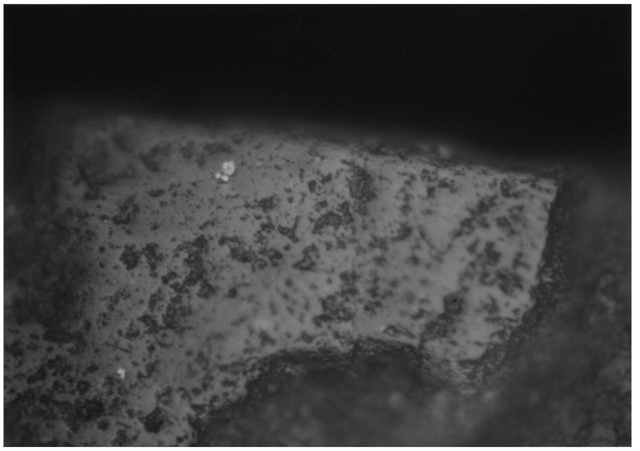


(6) 1.5-6. meat butcher. type E1D1. (SH56)

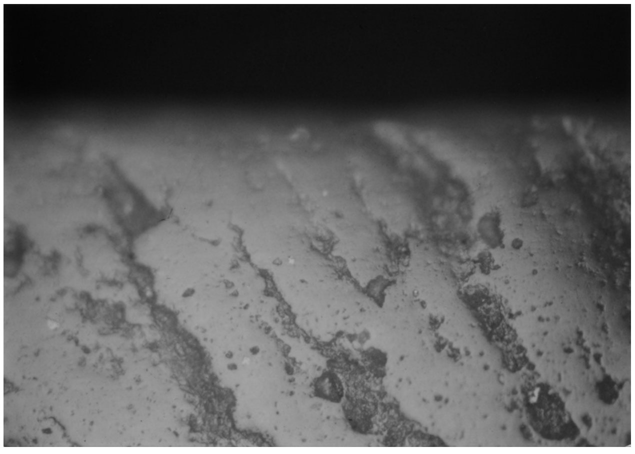
Figure 5. Experimental microwear polishes. (soft worked materials)



(1) 2.1-1. plant cut 2200st. type A. (SH140)

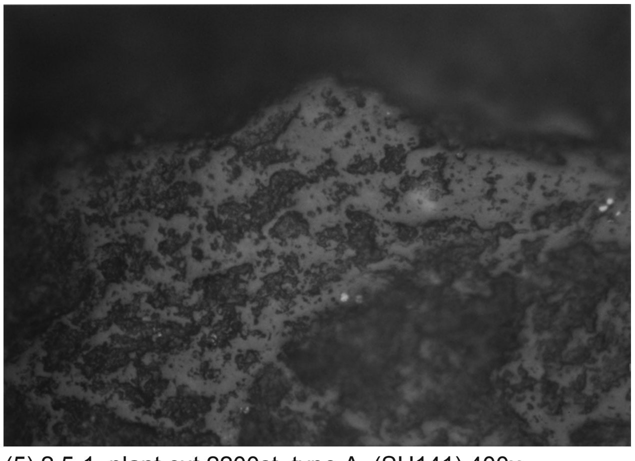


(2) 2.1-1. plant cut 2200st. type A. (SH140)

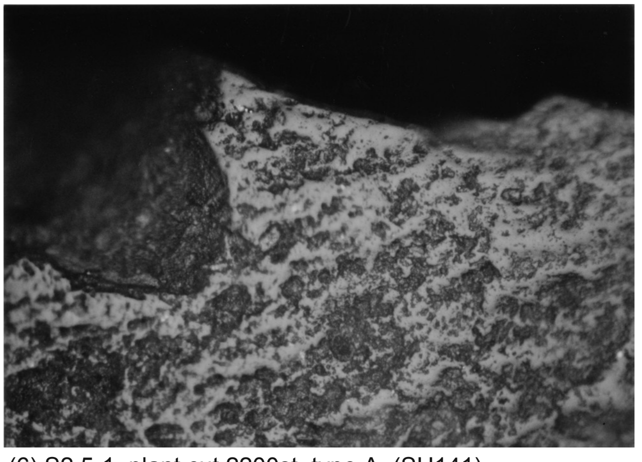


(3) 2.3-1. plant cut 3000st. type A. (SH43)

(4) 2.4-1. plant cut 3000st. type A. (SH40)

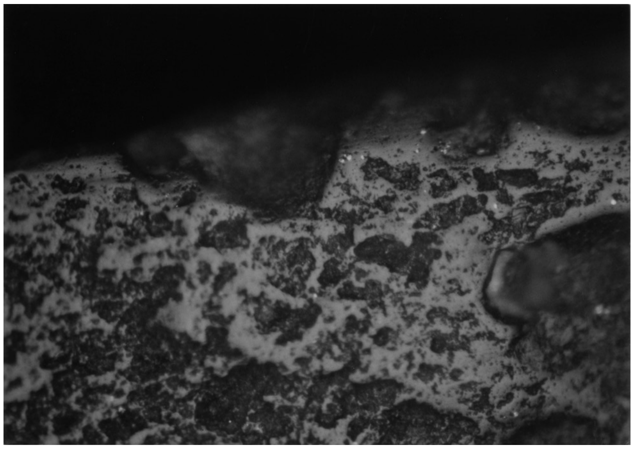


(5) 2.5-1. plant cut 2200st. type A. (SH141) 400x

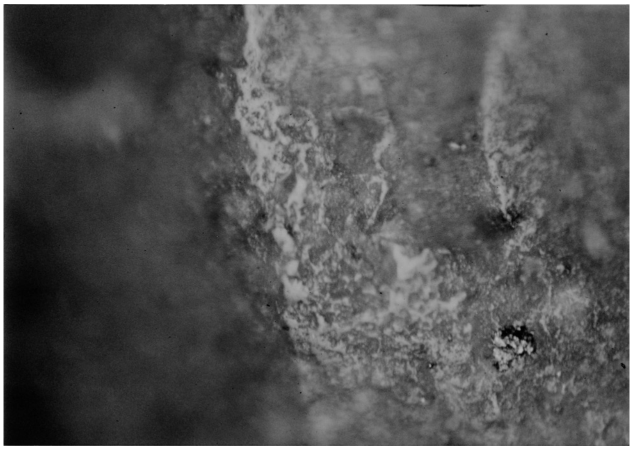


(6) S2.5-1. plant cut 2200st. type A. (SH141)

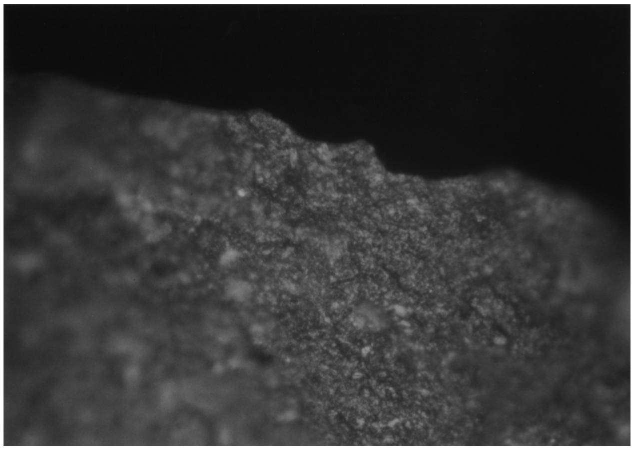
Figure 6. Experimental microwear polishes. (soft worked materials)



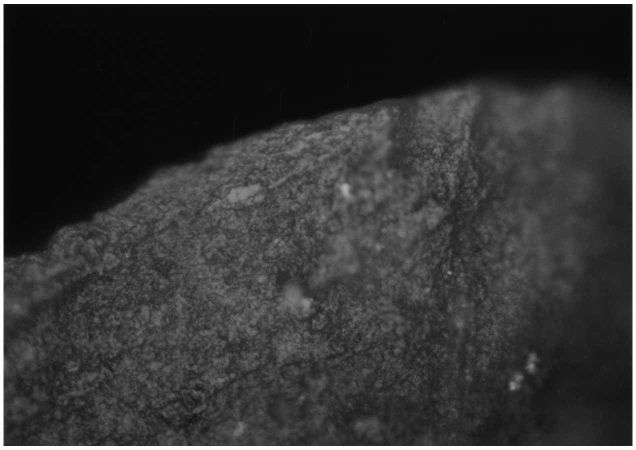
(1) 2.5-1. plant cut 2200st. type A. (SH141)



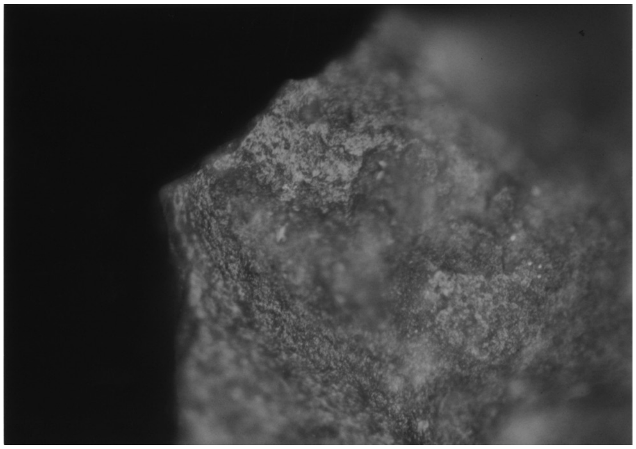
(2) 2.5-1. plant cut 1000st. type B. (SH155)



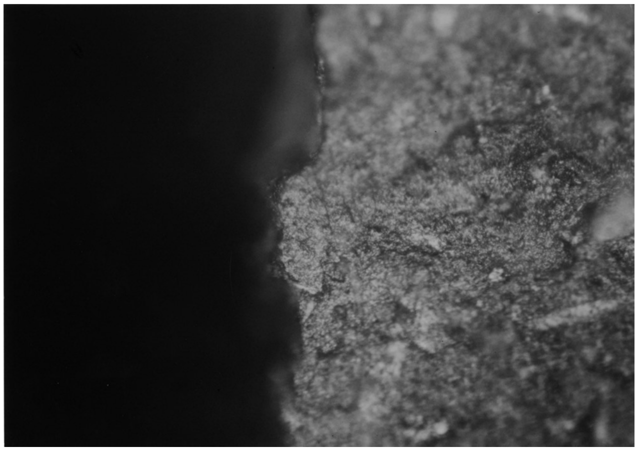
(3) 3.1-1. hide cut 250st. type F2. (SH32)



(4) 3.1-1. hide cut 1000st. type E1F2. (SH113)

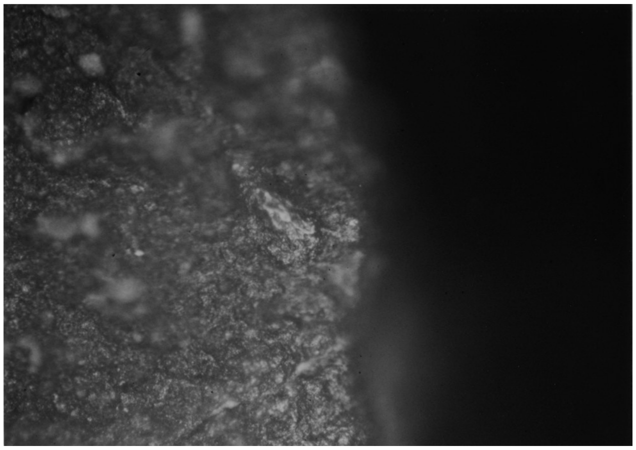


(5) 3.1-1. hide cut 1000st. type E2E1. (SH113) 400x

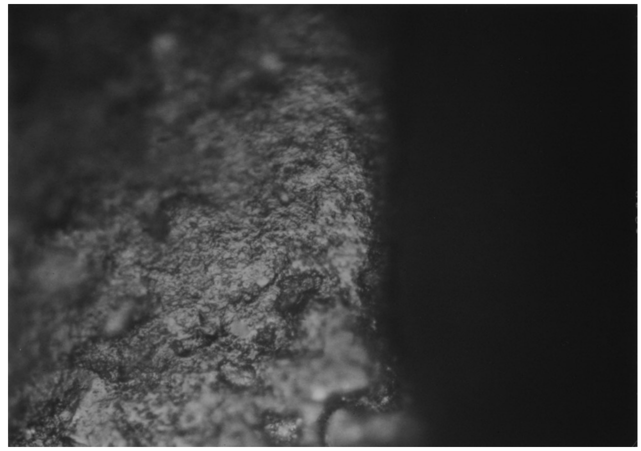


(6) 3.1-4. hide scrape 1000st. type E1. (SH24)

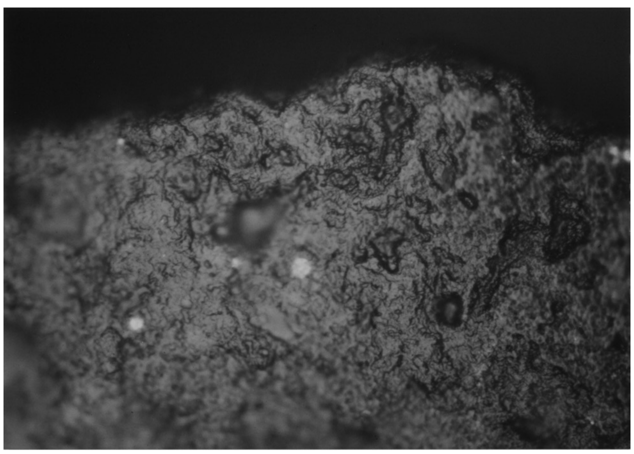
Figure 7. Experimental microwear polishes. (soft worked materials)



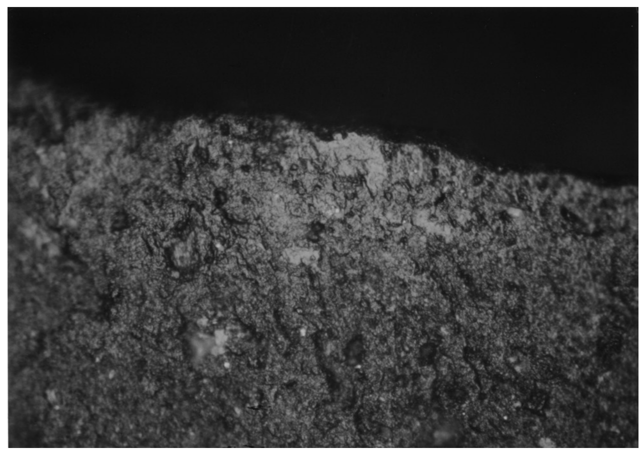
(1) 3.1-4. hide scrape. type E1. (SH28)



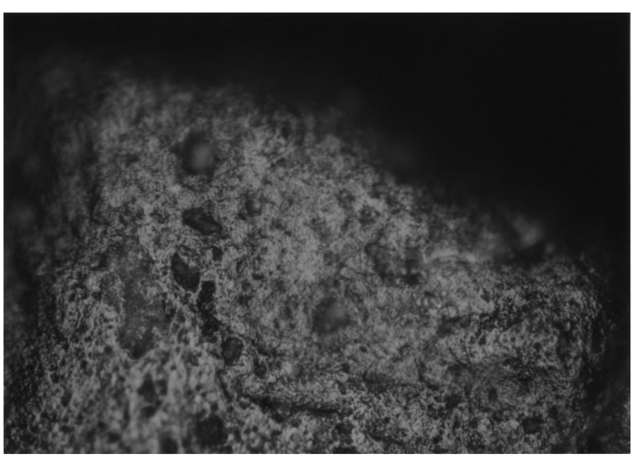
(2) 3.1-4. hide scrape 3000st. type E2. (SH29)



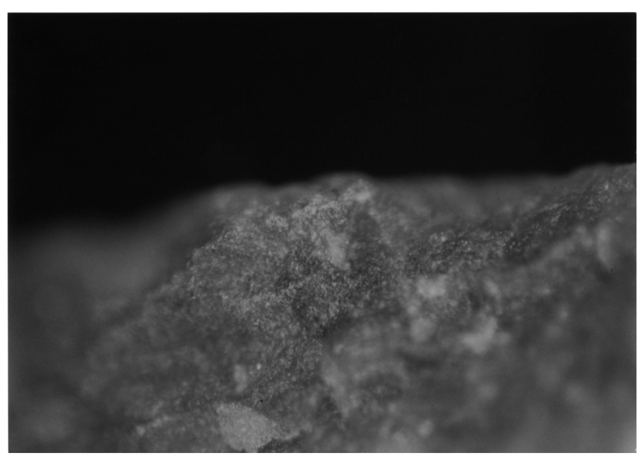
(3) 3.1-4. hide scrape 3500st. type E2. (SH29) 400x



(4) 3.1-4. hide scrape 3500st. type E2E1. (SH29)

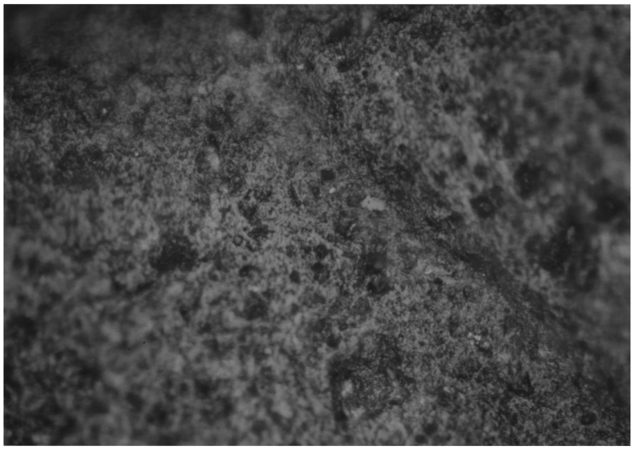


(5) 3.1-4. hide scrape 2000st. type E2. (SH35)

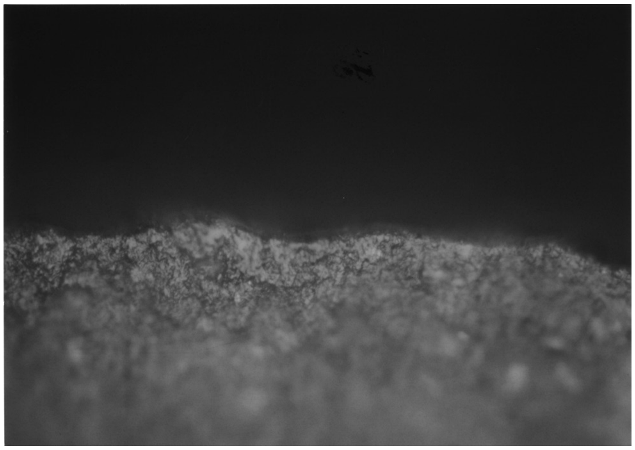


(6) 3.1-4. hide scrape 2000st. type E1. (SH112)

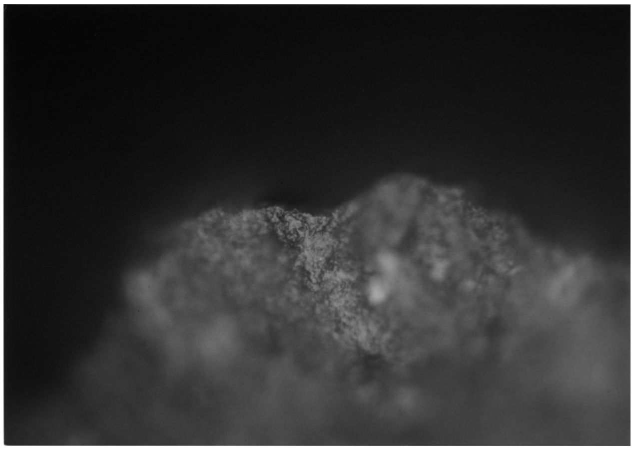
Figure 8. Experimental microwear polishes. (soft worked materials)



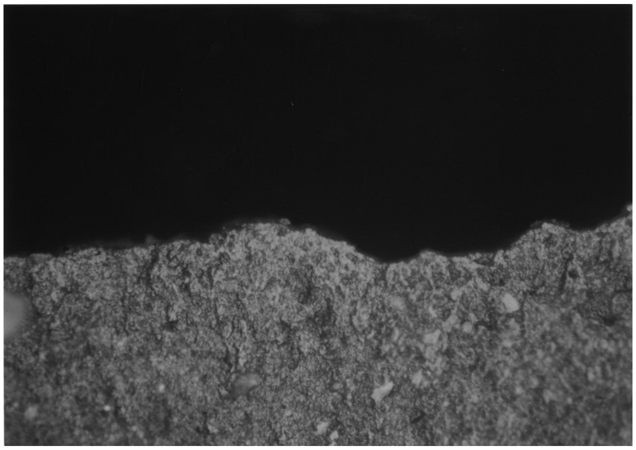
(1) 3.1-4. hide scrape 2000st. (SH116)



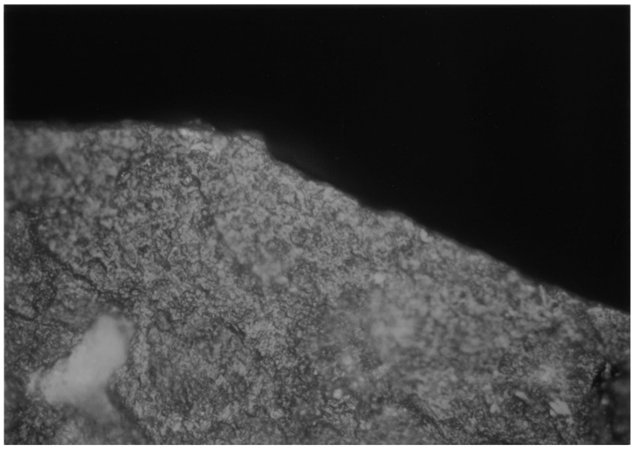
(2) 3.1-4. hide scrape 2000st. type E1. (SH117)



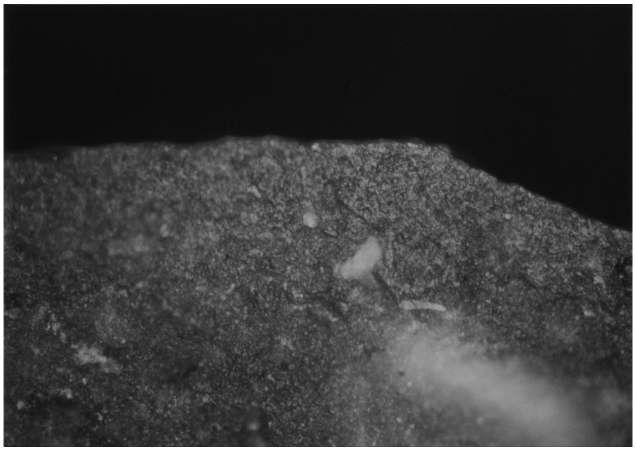
(3) 3.1-4. hide scrape 1000st. type E1. (SH118)



(4) 3.1-4. hide scrape 1000st. (SH119)

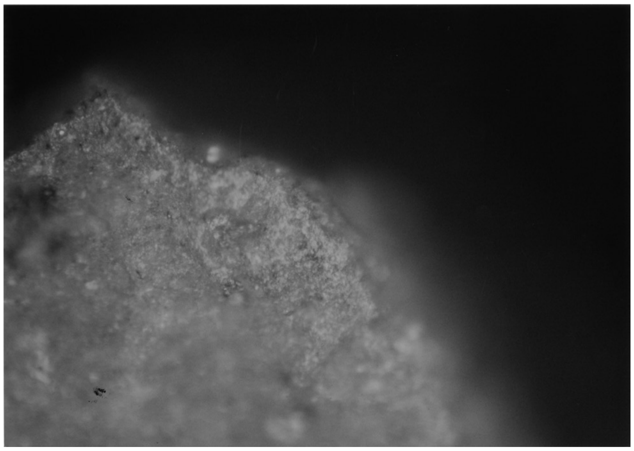


(5) 3.1-4. hide scrape 2000st. type E2. (SH120) 400x

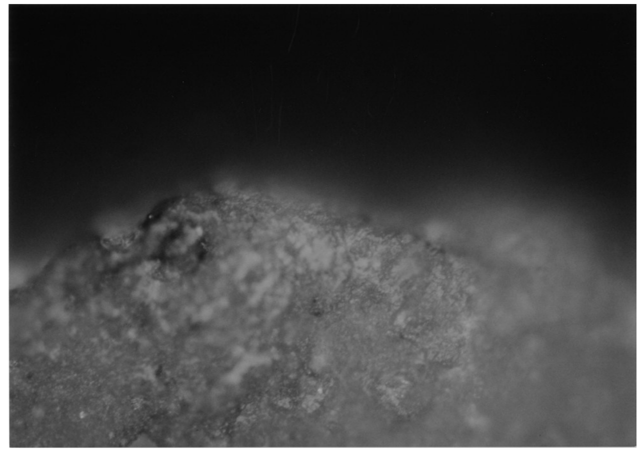


(6) 3.1-4. hide scrape 2000st. type E2. (SH120)

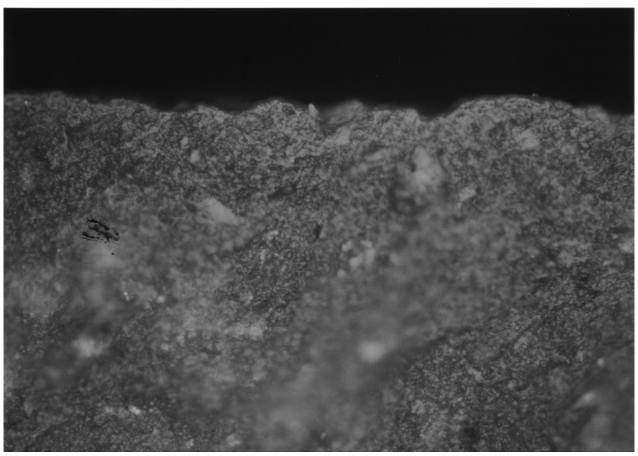
Figure 9. Experimental microwear polishes. (soft worked materials)



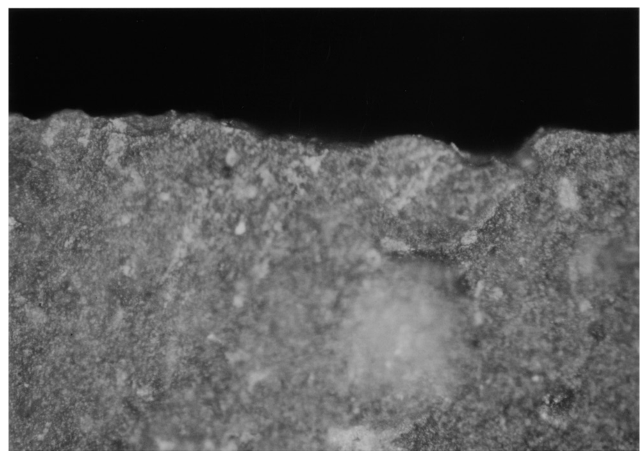
(1) 3.1-4. hide scrape 2000st. type E1F2. (SH120)



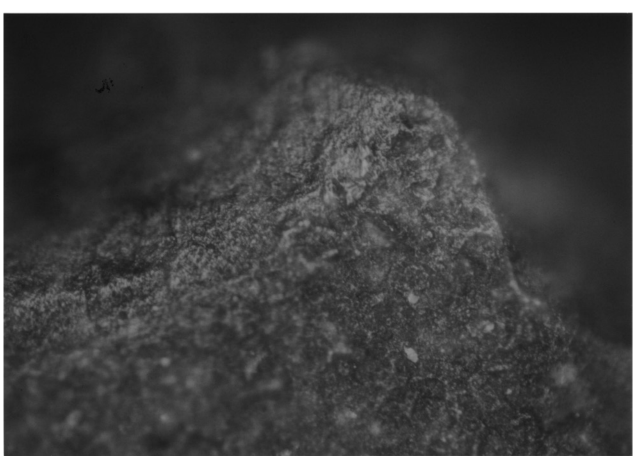
(2) 3.1-4. hide scrape 2000st. type E1. (SH120)



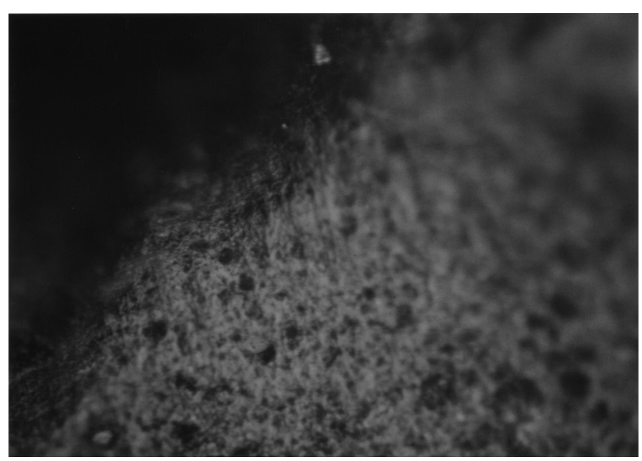
(3) 3.1-4. hide scrape 1000st. type E1E2. (SH121)



(4) 3.1-4. hide scrape 2000st. type E1E2 (SH121)

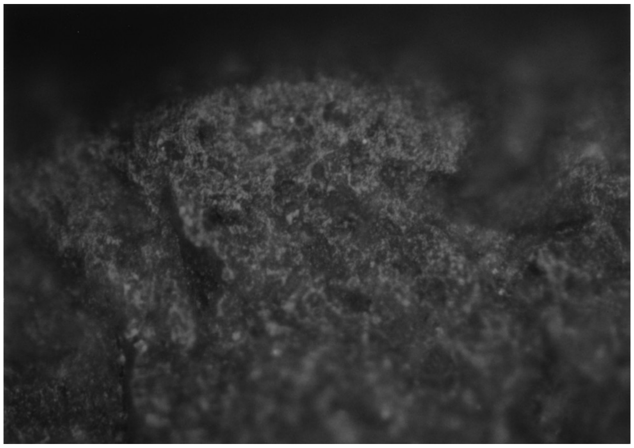


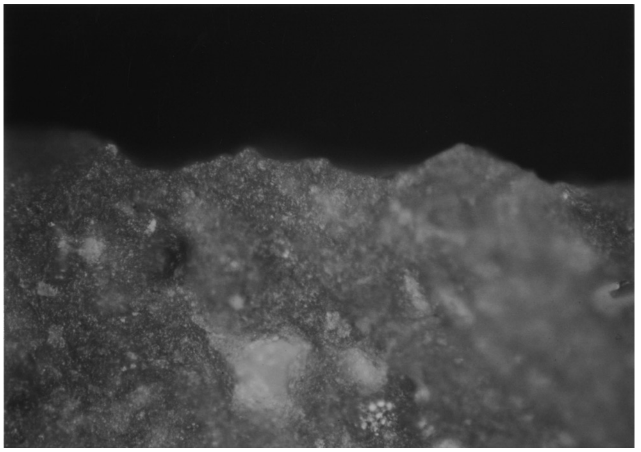
(5) 3.1-4. hide scrape 2000st. type E1E2. (SH123)



(6) 3.1-4. hide scrape 800st. (SH124)

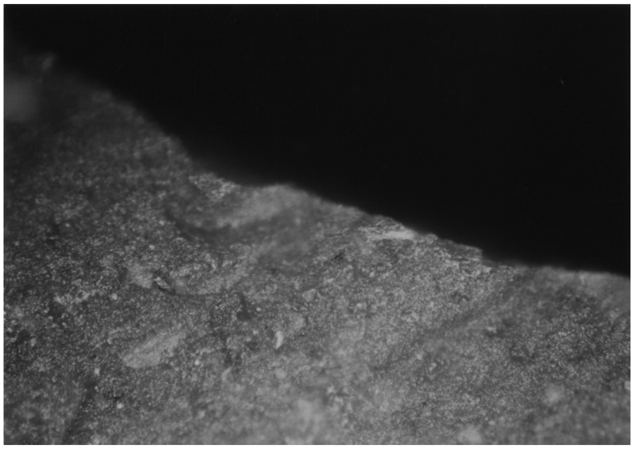
Figure 10. Experimental microwear polishes. (soft worked materials)


(1) 3.1-4. hide scrape 2000st. type E2. (SH125)


(2) 3.2-4. hide scrape 2000st. type F2. (SH128)


(3) 3.3-2. hide saw 5000st. type D2. (SH76)


(4) 3.3-2. hide saw 2000st. type E1. (SH76)


(5) 3.3-4. hide scrape 5000st. type F2. (SH74) 400x

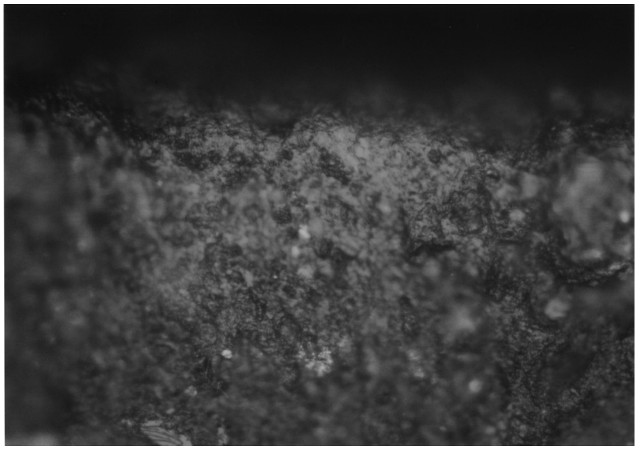
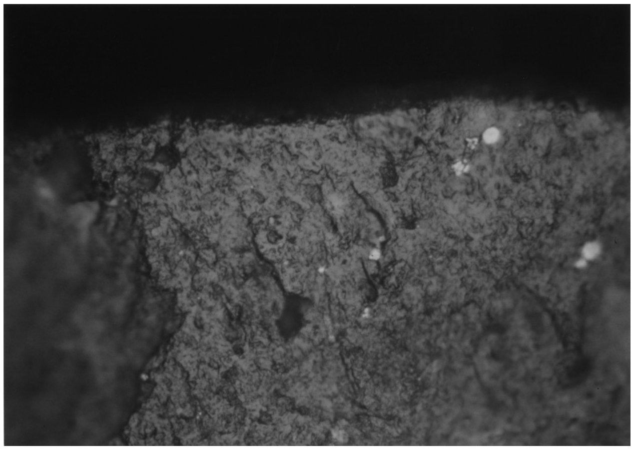
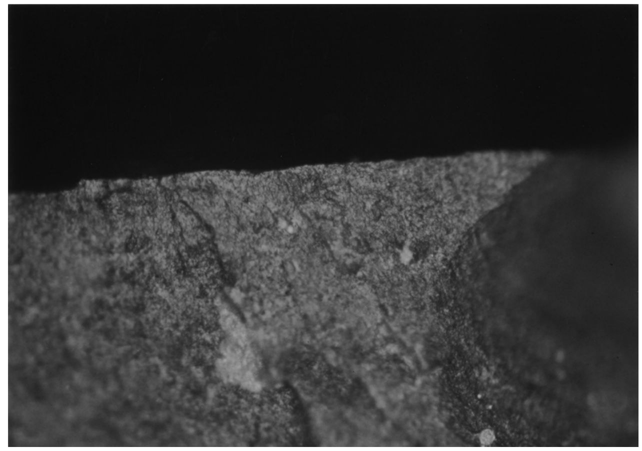

(6) 3.3-4. hide scrape 1500st. type E2E1. (SH130)

Figure 11. Experimental microwear polishes. (soft worked materials)

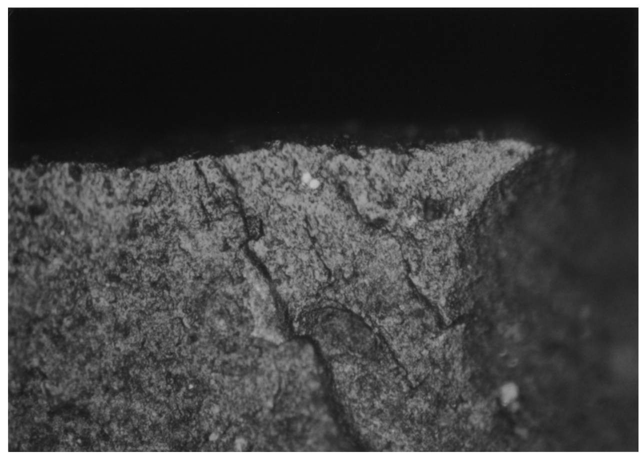


(1) 3.3-4. hide scrape 1500st. type E2. (SH131) 400x

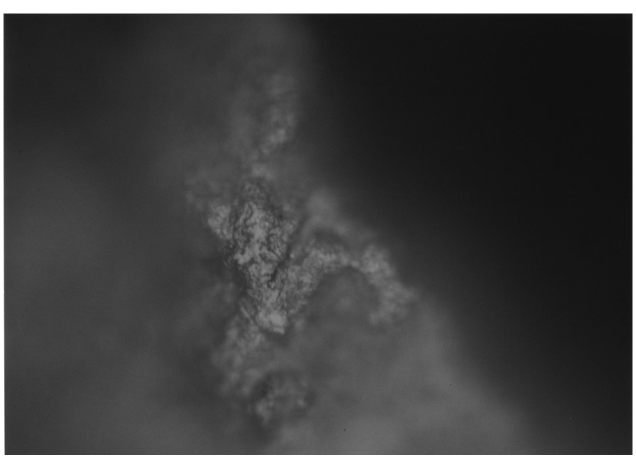


(2) 3.3-4. hide scrape 1500st. type F2. (SH131) 400x

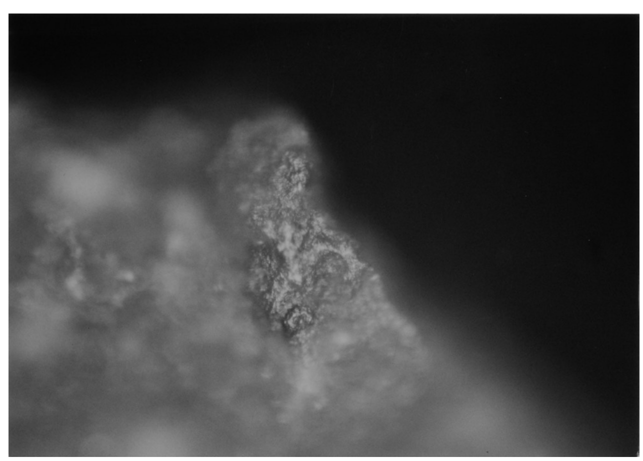
(3) 3.3-4. hide scrape 1500st. type E1E2. (SH131)



(4) 3.3-4. hide scrape 1500st. type E2. (SH131)



(5) 3.3-4. hide scrape 500st. type E1. (SH132) 400x



(6) 3.3-4. hide scrape 500st. type E1. (SH132)

Figure 12. Experimental microwear polishes. (soft worked materials)