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COMBINING EXPERIMENT AND ETHNOARCHAEOLOGY TO DIFFERENTIATE THE SURFACE CONDITIONS OF ANIMAL HIDES

ABSTRACT

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There is a wide range of technical processes involved in working animal skins, depending on the environment, the size of the skins and the purpose of the work (clothing, tent covers, *etc.*). The archaeological tools and their shape, weight, and use-wear are often the only evidence of these technical processes. Their understanding requires an experimental approach combined with ethnoarchaeological data to establish protocols allowing processes compatible with the type of skin to be treated and carry out the correct gestures at each stage of the process.

This study, dedicated to the processing of very large hides, presents the experimental replication of the production process of moose hides observed in Canada (B.C.) in an Athaspakan group. The functional analysis of the experimental tools allows identifying different wear patterns corresponding to different surface conditions of animal hides; each of them having particular implications for the interpretation of the archaeological record.

Keywords: Ethnoarchaeology; experiment; Use-wear analysis; Hide processing; Large hide
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INTRODUCTION

The ethnographic record of the traditional ways of working animal skins shows that a broad range of techniques can be used. Although the choices of techniques are closely related to the cultural context and the social organisation, they also depend upon the particular animal, the intended use for the skin and the environment (Perkins *et al.* 2008; Frink and Weedman 2005; Audoin-Rouzeau and Beyries 2002). According to the dimensions and particularly the thickness of the skin to be treated, several elements can differ. These include the method of tensioning (stretched on a frame, on the ground, on a plank), the shape of the tool's working edge, the tool's weight, and the materials it is made of (bone, stone, metal) (Gallagher 1974; 1977; Beyries 2008; Beyries 2003; Beyries and Rots 2008b; Weedman 2006; Steinbring 1966; 1992; D'iatchenko and David 2002; David *et al.* 1998; Delaporte and Roué 1978; Robbe 1975; Beyries and Rots 2008a, 2008b; Tepper 1994; Emmerich Kamper 2020; Kobayashi Issenman 1997; Klokkernes 2007; Clark and Kurashina 1981; Schultz 1989). The stone tools usually have handles and the gestures practiced with these tools are correlated with the method of stretching the skin, its state (fresh, dried, rehumidified, soaked) and the shape and weight of the handles into which the tools are inserted. Following several ethnoarchaeological studies carried out in different traditional communities that practice the working of hides using various technical methods, in the Canadian British Columbia (Athapaskan), in the Siberian Far East (Chukchi, Koryak) and in Ethiopia (Konso, Gamo) (Beyries 2002; Beyries 1999; Brandt and Weedman 2002; Weedman 2000), it has been demonstrated that the formation of wear traces on the working edges of the tools used vary significantly from one technique to another (Beyries 1999; Beyries and Rots 2008b, 2008a).

In the archaeological record, the poor preservation of skin render the importance of this material in daily life difficult to discern. Vestiges are rare and often difficult to interpret (Beyries 2002; Beyries *et al.* 2001); the tools, made of stone or bone, generally provide the only evidence that comes down to us. Thus, it is based only on the study of these tools that it may be attempted to determine the techniques employed. Once the technical process has been identified and the conditions in which these processes take place has been defined (presence or absence of water, wood, *etc.*), it is possible, under certain conditions, to approach the organisational aspects of the groups studied, such as the rhythms of nomadisation, for which hide weights, stretching methods and process segmentation can provide crucial data (Audouze and Beyries 2007; Gauvrit-Roux 2019; Gauvrit-Roux and Beyries 2018).

To be validated, the observations made in present-day contexts should be subject to experiments in order to enable control of parameters such as intensity of the physical gestures (force and amplitude), variations in the state of the skin at different moments of being worked, the duration of the preparation of a skin – difficult to determine precisely during fabrication in a real situation.

In this perspective, in collaboration with the *Centre Archéologique de Pincevent* (Seine-et-Marne, France), an experimental program of two years was set in place in 2014 and 2016. This consisted of working hides of very large size close to that of moose hides, with the techniques observed in 1994 and 1995 in the Athapaskan Beaver-Doig River communities in northern British Columbia (Beyries 2002; Beyries 1999; Beyries 2008). Two skins of adult bisons (*Bison bison*) raised in captivity were worked. The skins were thicker than that of a moose (*Alces alces*), in particular for the rump, the shoulders and the length of the spine (3 to 4 cm vs. 1 to1.5 cm). One of the skins was stretched on the ground, the other on a wooden frame; these two techniques are the only ones that allow skins of this size to be properly tensioned. Throughout the defleshing, hair removal and thinning, this skin remained stretched on a single frame. All the stages were carried out with bone scrapers and hafted stone end-scrapers.

The aim of this experiment was to understand the variability of marks that can be observed on tools during the different stages of working a large skin stretched over a frame. The first year, two weeks in July 2014 were devoted to defleshing and hair removal. The latter was carried out by striking with two bone tools and one stone tool. One of the bone tools, shaped by working a deer (*Odocoileus hemionus*) metapodial, was brought from Canada; the other was created on the site by working the metapodial of a bullock (*Bos taurus*). The second year, two weeks in 2016 were devoted to the thinning of the skin on the flesh side. In this article, we will deal only with the skin stretched on a frame and the stage of thinning (2016 session).

THE EXPERIMENTAL PROCESS

Stretching the skin

The stage of stretching the skin so that it was under tension began with the fabrication of a frame in fresh ash wood (*Fraxinus*; 4.80 × 3.80 m). Once the frame was constructed, it was leaned against two trees (Fig. 1).

The skin was preserved frozen between the two sessions of experiments. This method of preservation was chosen because, after slow thawing, the skin returns to its original state. In fact, all we do is change the state of the water contained in the tissues. When ready to start the experiments again, it was left to thaw in the open air, then immersed in water to recover its elasticity.

Once the skin had recovered its original state of humidity and size, it was spread on the ground under the frame without any particular precautions (*i.e.*, the ground was not cleaned before spreading); it was then stretched on the frame with ratcheted straps, beginning at the top then progressing symmetrically around the frame. When it had been stretched and rinsed with a jet of water, it was left until completely dry; here three days were necessary for the drying on account of the ambient temperature and the thickness of the skin.

a b

Fig. 1. Moose hide stretched on a 3.5 m2 frame, Doig River, British Columbia, 1994 (a), Bison hide stretched using the same technique, Pincevent, 2014 (b)

When drying, the skin shrank, and the straps tightened progressively; when completely dried the skin was stretched to maximum tension.

When cleaning or removing hair from the skin, the skin must always be under tension when the cutting edge of the tool comes into contact with it. It's the intensity of the tension that ensures even thinning without the risk of tearing. This stage of stretching is essential as it guarantees the proper progression of all the following operations; whatever the process, the efficiency of the tools is correlated with the tension of the stretched skin that is necessary for its treatment.

The fabrication of the tools

In parallel with the placing of the skin under tension, we fabricated the composite tools for the reduction of the thickness of the skin.

A series of blades in Senonian flint from the north of the Paris basin were knapped by direct percussion with a tender organic striker by an experienced knapper (P. Bodu, CNRS UMR 8068 Temps). On the distal extremities, the fronts of the wide and convex end-scrapers were formed by direct retouch.

Three end-scrapers were fitted into bent wooden handles, and 13 were fixed into straight handles fabricated on the site by each experimenter (Table 1). These are sections of fresh, de-barked ash wood of about 30 × 5 cm which were shaped. A slit to insert an end-scraper was made on each of the handles with a metal knife. The insertion of the end-scraper was occasionally accompanied by light percussion on the front with a hard material; the tool was inserted to the maximum to stabilise it. The sharp stone tool was fixed to the handle with ligaments and rough leather strips that had been soaked; the composite tool was then left to dry. While drying the leather shrank and the tie became more solid. The scraping of the skin could begin as soon as the ties around the handles were dry (Fig. 2).

Seven days of scraping were necessary to reduce the thickness of the hide over approximately two square meters of the skin, that is, half of the complete hide.

Table 1. Functional parameters for the 16 experimental tools

Tool N°	Haft type	Working angle	Amplitude of the gesture	Launched percussion	Position of the experimentator on the hide	Position of the experimentator relative to the tool	Sharpening	Length of the flint tool *before* sharpening (mm)	Length of the flint tool *after* sharpening (mm)	Working time after the last sharpening (minutes)	Edge morphology before sharpening	Edge morphology after the last sharpening
1	straight	*ca.* 90°	low	light	seating on the hide	facing it	no	57	–	30	convex	–
3	straight	60-80°	high	violent	standing up in front of the hide	facing it	yes	52	47	60	convex	rectilinear
4	bent	*ca.* 90°	high	light	seating on the hide	variable	yes	71	65	40	convex	rectilinear
7	straight	*ca.* 90°	low	light	seating on the hide	lateral	yes	67	63	70	convex	rectilinear
8	straight	*ca.* 90°	low	light	seating on the hide	facing it	yes	56	51	25	convex	rectilinear
9	straight	*ca.* 90°	low	light	seating on the hide	lateral	yes	73	63	45	convex	convex
10	straight	45-60°	high	violent	standing up in front of the hide	facing it	yes	48,5	48	30	convex	convex
11	straight	*ca.* 90°	low	light	seating on the hide	lateral	no	30	–	5	convex	–
12	straight	45-70°	low	light	seating on the hide	facing it	no	67	–	25	rectilinear	–
13	straight	30-45°	low	light	seating on the hide	facing it	yes	71,5	71	15	convex	denticulated
14	bent	*ca.* 90°	low	light	seating on the hide	facing it	no	62	–	45	convex	–
15	bent	*ca.* 90°	low	light	seating on the hide	facing it	no	75	–	30	convex	–
16	straight	*ca.* 90°	high	light	seating on the hide	facing it	no	56	–	30	convex	–
17	straight	*ca.* 90°	low	light	seating on the hide	lateral	yes	59	48	10	convex	convex
18	straight	*ca.* 90°	high	violent	seating on the hide	lateral	no	53	–	20	rectilinear	–
24	straight	*ca.* 90°	low	light	seating on the hide	lateral	no	46	–	5	convex	–

a b c d e

Fig. 2. Immobilisation of a flint blade with wet leather laces (a), b and c) Distal end of the handle (b and c), bent handle used for the experiment (d), straight handle used for the experiment, Pincevent, 2016 (e)

Thinning the hide

The reduction of the thickness follows the defleshing and hair removal, its objective being to make the reticular layer (dermis) thinner (Chahine 2002; Beyries 2008; Emmerich Kamper 2020). The duration of the stage of thinning is correlated to the thickness of the skin and to the objective to be attained.

This stage was carried out on dry skin, *i.e.*, completely dehydrated skin without any elasticity. Bison hide is very thick and also very hard when it is dry and stretched under tension; for instance, sitting upon it produces no deformation.

The work was carried out by scraping to eliminate the successive layers of dermis. The extreme hardness of the reticular layer and its high fat content often prevented the tool from biting into the dermis. When this occurred, local and very superficial rehumidification was applied. Unlike soaking, in which water impregnates the heart of the hide, rehumidification is selective and superficial. To rehumidify, the hide is wetted very selectively with a little water, preferably tepid, and rubbed by hand so that it lightly penetrates the upper part of the dermis. This operation relaxes the dermis, releases and swells the surface fibers of collagen. The hydrated part of the dermis, which takes on a milky colour indicating the saponification of the fats, becomes easier to work. After rehumidification, the tool can again bite into the skin. Selective rehumidification facilitates the removal of matter using a tool and enables evaluation, by the change in colour, of whether fat remains on the skin. The operation can finish when all fats are removed from the skin (Steinbring 1966; Beyries 1999; Beyries 2008; Emmerich Kamper 2020). The scraping operation is continued until the desired thickness is obtained.

Position of the body, handling of the tools and gestures performed

Given the size of the frame, the working of the highest and most central parts requires sitting upon the skin; a wooden bar is placed transversely to stabilise the workers on the frame inclined against the trees (Steinbring 1966; Beyries 1999; Beyries 2008; Emmerich Kamper 2020). For the parts closest to the ground or on the edge of the frame, it was possible to work standing up, leaning above the hide (Fig. 3).

The tools were held in two hands: in this case one of the hands was very close to the working edge which enabled force to be applied in the gesture, while the other hand at the middle or at the extremity of the handle, enabled the movement to be directed.

a b

Fig. 3. Position of bodies: a) Moose hide, Doig River, B.C., 1994; b) Bison hide, Pincevent, 2016

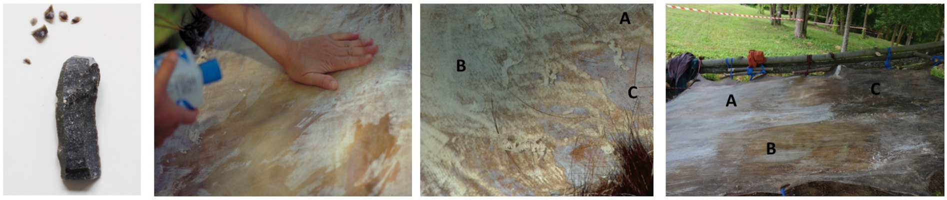
Fig 4. Tools working angle. Moose hide, Doig River, B.C., 1994 (a). Bison hide, Pincevent, 2016 (b)

Sometimes the tool was held with only one hand; in this case one hand performed both roles (Fig. 4).

The choice of the manner of grasping the tool was instinctive according to the position of the three craftswomen and the zone of the skin being worked or the tiredness of the arm. The amplitude of the gestures, the force used and the working angle of the tools varied according to the positions of the craftswomen: an angle for working of between 30 and >90° for the straight handles and around 90° for the bent handles. The gesture used was a thrown percussion, the tool being pulled once in contact with the skin. It was necessary to regularly clean the cutting edge as it became clogged with fat contained in the dermis that accumulated on the edge. The percussion was very light and controlled and did not create splinters.

Resharpening of the tools

The first tools rapidly became worn; after ten minutes the cutting edges became blunted and lost their efficiency. The skin was very dry and dirty (and thus abrasive), and thick



a b c d

Fig. 5. Sharpened tool during the Pincevent experiment, 2016 (a). Local moiturising of a moose hide to saponify the fat, Doig River, B.C., 1994 (b). A – Unscraped hide; B – Dry thinned hide; C – Saponified fat on the hide; The hide is correctly cleaned when it loses its iridescent appearance on contact with water (c). Experimental hide, Pincevent, 2016; A – Dry thinned hide; B – Rehumidified hide; C – Dirty hide (d)

and dirty. Despite washing, residues of dust, sand and earth related to transporting the skin and setting it in place were present. These residues were highly abrasive, and significant blunting rapidly appeared. The hardness and thickness of the dry bison skin rendered it particularly difficult to work.

Two technical solutions were thus rapidly adopted to allow the tools to properly work the dermis (Fig. 5):

– The tools were frequently resharpened;

– The skin was regularly rehumidified locally.

The resharpening was carried out using direct percussion with a hard striker on an anvil. Without resharpening, the blunt tool slid on the skin, in particular on the thick and very fatty zone of the spine.

Successive sharpenings of a tool modify the angle of the cutting edge and can generate hinged removals which obstruct further resharpening and thus lead to abandonment of the tool. This also leads to a reduction in the length of the tools, and finally the space between the active edge and the handle is too short for the tool to be efficient (the handle scrapes the skin). In anticipation of this reduction in length of the stone tools after successive sharpenings, the distal part of the wooden handle was made thinner by a metal knife so that the handle would not be in direct contact with the skin (Jardon and Sacchi 1994). The reduction of length is variable and ranges between 11 mm and 0.5 mm in relation to the length of the flint tool at the beginning of use. The successive sharpenings do not always change the morphology of the tool front, which remained convex for three of the eight tools sharpened; four tools changed from convex to rectilinear and one tool from convex to denticular. Following the sharpening of the end-scrapers, certain fronts presented a slight denticulation. This irregularity in the cutting edge could have been desirable as it enabled the tool to better bite into the dermis. In certain cases, the cutting edges were evened to increase the zone of contact of the front.

Replacement of fats

Once the phase of thinning by scraping was achieved, the skin was washed with water to remove the shavings of skin, then left to dry. This time, the drying phase took only a few hours as the water had not penetrated to the interior of the skin.

Then it was necessary to replace the unstable fats of the skin by regreasing with a more stable fatty matter to help make the skin supple. In a traditional context, a number of fatty substances can be used: cooked brain crushed by hand, olive oil… We applied by hand about 1.5 kg of vegetable fat (melted margarine) on the scraped surface; 24 hours later, the skin was washed with black soap diluted in hot water while being rubbed with a stiff-bristle brush and scraped with a metal knife (Fig. 6).

Softening

Making the skin supple, it being still in the frame and lightly stretched, was achieved by beating it with wooden sticks to break the fibres. This enabled the smoke to penetrate the leather during the stage of smoking (Fig. 7). Softening took place over several hours.

a b

Fig 6. Greasing a moose hide with melted margarine, Doig River, B.C., 1994 (a). Greasing a bison hide with margarine, 2016, Pincevent (b)

a b

Fig. 7. Softening a moose hide by hitting it with scrapers, Doig River, B.C., 1994 (a). Softening a bison hide by beating it with a wooden stick, Pincevent, 2016 (b)

Cutting the skin

The skin was then cut near the eyelets to remove the frame. This operation was performed with unretouched flakes and blades, then with a metal wood-saw. This phase was difficult in certain parts; even after the thinning, the hard edge of the thick skin was still very thick after the fat had been removed (5-7 mm) and the zone of the spine was also thick (3-5 mm). The skin of the flanks was however thinner (1-3 mm). The cutting operation needed an hour of work and much force as the material is very resistant.

Smoking the skin

For smoking the skin, we dug a hole of about 50 × 50 × 50 cm, gathered fresh moss and rotten wood, which are available in large quantity at the place of experimentation, and lit the fire. The skin was positioned above the hole, leaving a space for the oxygenation of the hearth. The burning of the moss and the rotten wood created dense smoke that penetrated the skin positioned over the hole (Fig. 8). During this operation, the aldehydes (alcohol) and phenols contained in the smoke, by combining with the collagen in the skin, enable it to remain supple. The heat reinforces the tanning effect of the fats previously introduced by oxidizing them. The gases filled with alcohols, ketones, essential oils and tar penetrate the fibres of the skin, which ensures good preservation and impermeability (Chahine 2002; Beyries *et al*. 2001; Beyries 2008; Emmerich Kamper 2020). The tars gave a yellowish tint to the skin (Edholm and Wilder 1997).

a

b

Fig. 8. Smoking structure; Doig River, 1994 (a) Pincevent, 2016 (b)

Different states of the surface during the treatment of one skin

The state of the surface of the skin varied during the course of thinning; thus, at the beginning we worked a dirty skin with abrasive particles from the ground on which the skin had lain, then a dry skin, then a dry skin with a dermis rehumidified selectively and superficially. The analysis of the tools used was carried out with a stereomicroscope Leica Z16 APO ×10-×180 and a reflected light microscope Leica DMRM ×100-×200 (Fig. 2).

The dirty skin with abrasive particles

The beginning of the work was carried out on a skin covered with sandy sediment and/or earth containing plant material. These abrasive elements were deposited on the wet skin when it lay on the ground before being installed on the frame; at no point was an abrasive element deliberately added.

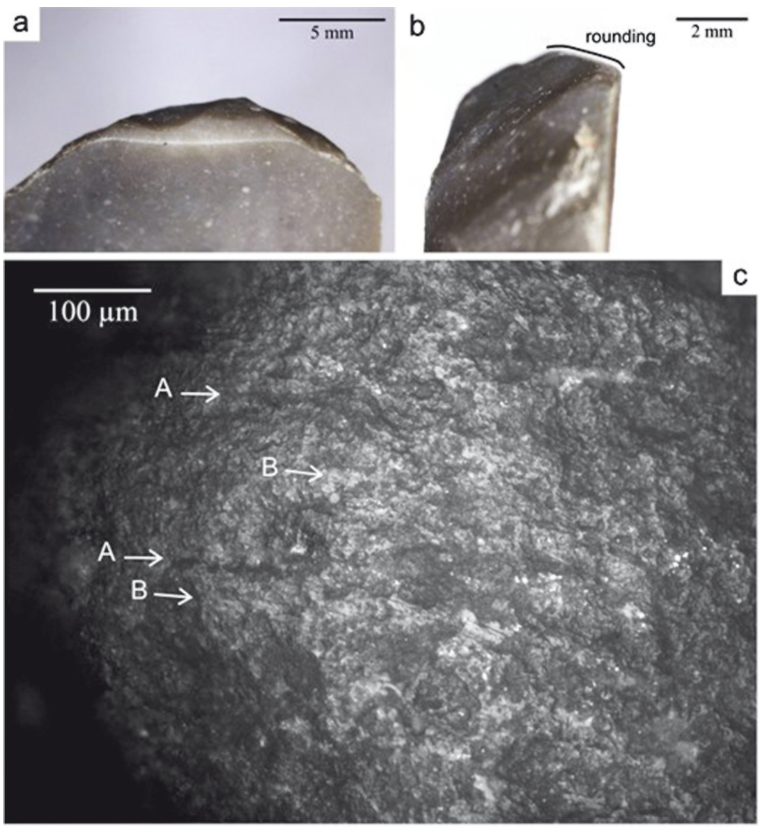


Fig. 9. Traces due to scraping dirty dry hide. Intense rounding of the working edge (a, b). Micro-wears with two types of striations: long deep striations with a rough bottom (A) and fine short striations with a smooth bottom (B) (c)

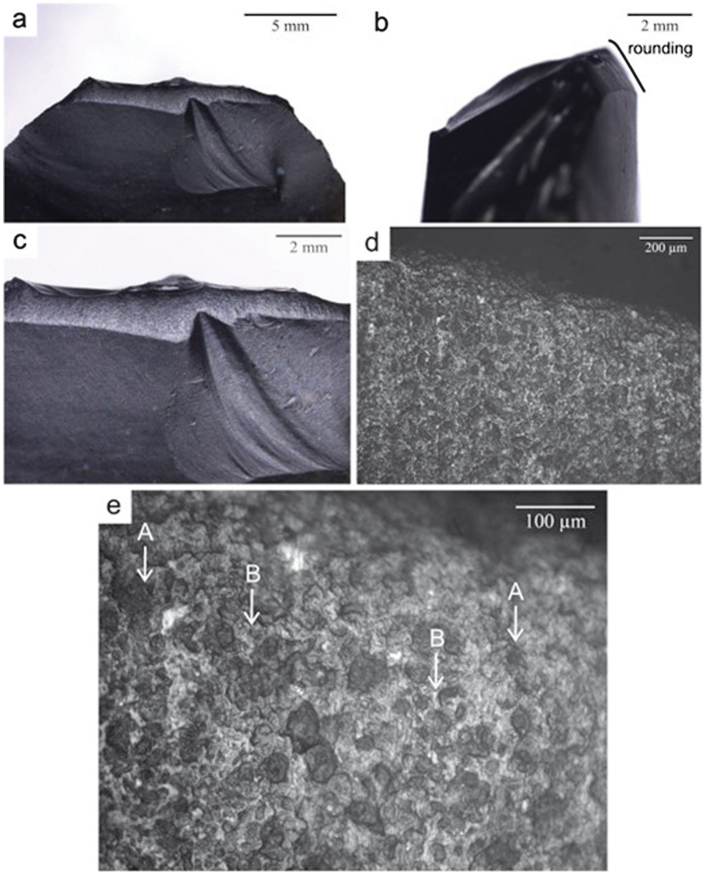


Fig. 10. Traces due to scraping dry hide. Intense rounding of the working edge (a-c). Micro-wears with two types of striations: deep, wide and long striations (A) and abundant thin striations with a rough bottom (B) (d, e)

The end-scrapers used for cleaning the skin developed significant rounding, leading even to the appearance of large flat areas related to the abrasive particles contained in the sediment. The many striations are of two types: on the one hand fine short striations with a smooth bottom, which correspond to the contact with mineral particles; on the other hand long, deep striations with a rough bottom, which correspond to contact with abrasive particles of skin-shaving type or with larger mineral particles. The polish is dull, irregular and rough with an open network (Fig. 9).

The dry skin

The dry skin caused well-developed areas of rounding where flat areas were formed on the cutting edge when the work angle was stable. The many striations are of two types: the most numerous are fine, with a rough bottom, relatively superficial and moderately long, typical of working on dry skin. Other striations, less frequent, indicate contact with a hard and abrasive material, such as the residues of dirt and/or large shavings of dry skin removed by the scraping. These striations are long and deep with a rough bottom. The polish associated with the working of dry skin is dull with a rough and irregular aspect and a closed network (Fig. 10).

The skin locally rehumidified

The working of a skin that has been locally rehumidified also causes well-developed rounding that forms a flat area if the work angle is stable. Most striations are fine, short, relatively superficial, with a bottom that is rough or even smooth; others are deep, wide and long. On the high points of the microtopography, the polish is smooth and brilliant with a closed network; it corresponds to contact with the skin that is fatty and humid on the surface. On the low points of the microtopography the polish is dull, rough and irregular, with a semi-closed network; the latter corresponds to contact with dry skin (Fig. 11).

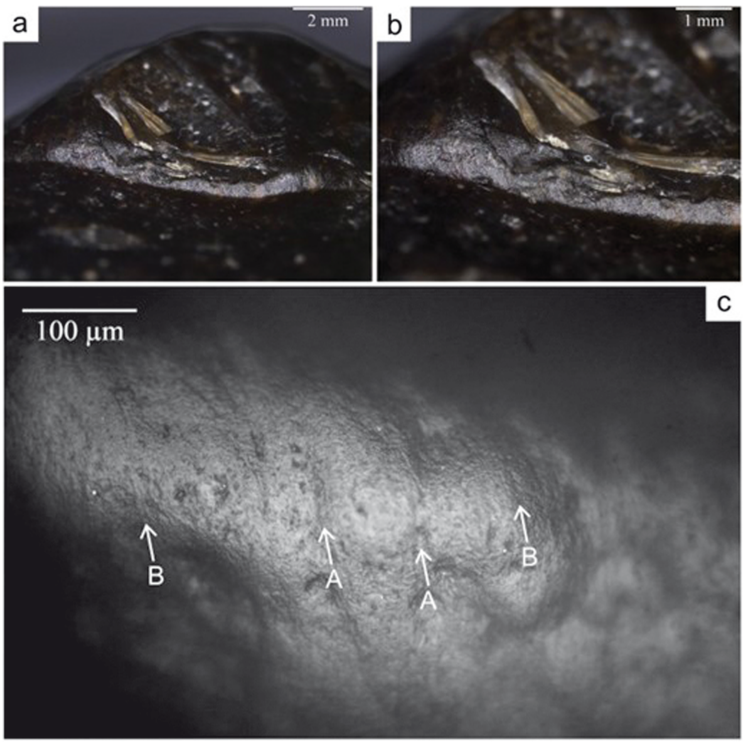


Fig. 11. Traces due to scraping rehumidified dry hide. Intense rounding of the working edge (a, b). Micro-wears with two types of striations: deep, wide, and long striations (A) and thin, relatively superficial striations (B) (c)

Differentiation of these states of the surface: implications for the archaeological record

The rounding alone does not allow discrimination between a dry skin, a selectively rehumidified dry skin and a dirty dry skin; the only differences that can appear correspond to the morphology of the abrasive particles deposited. More generally, the morphology of the rounded area is a parameter to be approached with caution as it does not depend only upon the hardness of the skin (which can vary according to the degree of dryness and/or the tension at which the skin is stretched). The morphology of the blunted area is also dependent upon the gesture used to work the skin (variation or stability of the angle of the tool, amplitude, force applied); the influence of this parameter is closely correlated to the type of handle and to the position of the skin and/or to that of the craftsperson.

Although the demarcation of the polish is not so pertinent, the topography, the intensity of light reflection and the striation network appear to be discriminating factors. The working of a dry skin causes an irregular surface to appear on the tool which reflects very little, whereas humidification of the skin surface wears down the high points of the polish, thus increasing light reflection.

Concerning dust particles/dirt on a dry skin, the result seen on the tool depends on the hardness, density and morphology of the abrasive particles (size and angularity) as well as the amount of humidity. The dust particles increase the irregularities formed on the surface; the more abrasive the particles are, the more the surface is irregular and less reflective.

The lower the level of humidity of the skin, the more accentuated the striations will be. For a clean skin, the width, the length and the aspect of the bottom of the striations (rough/smooth) are to be correlated to the amount of humidity.

In an archaeological context, the identification of these states of skin provides information of different orders.

The identification of a non-specific abrasive during treatment of the skins does not signify that its addition is voluntary. On the other hand, its presence can indicate the beginning of work on a skin that was kept without any particular precautions. With archaeological material, it will be in any case generally impossible to identify whether the abrasive was an intentional addition (additive) or not (dirty skin); the traces obtained at this stage are thus extremely difficult to interpret.

The working of dry skin can involve the treatment of skins of varying thicknesses with distinct methods of applying tension and different stages of the process (defleshing, thinning, epilation). The working of a dry skin stretched on a frame, for stages of epilation and/or thinning, should always be carried out on a skin presenting no elasticity. A very dry skin, stretched on a frame, rapidly wears out the cutting edges of the tools and frequent sharpening is necessary.

In an archaeological context, the identification of a dry skin that has been selectively rehumidified provides crucial information for defining the type of process set in place (type of skin worked, method of tension, stage in the *chaîne opératoire*); it gives key information to at least grasp the minimum duration of the presence of a group on a given site and possibly the function of the site:

The working of a skin that has been selectively rehumidified is a strong indicator, as this stage occurs only for the thinning of a thick skin stretched on a frame. The analysis of the distribution of traces according to the microtography of the surface of the tool (*cf.* supra) enables identification of this stage, which is often wrongly interpreted as the working of a humid skin (that is, a fresh or soaked skin). The working of this type of skin implies a period of immobilisation of the human group of at least 2 weeks, as the stretching frame is large and heavy and thus not transportable. This minimum duration for the thinning of a thick skin can increase according to the climate, which is a determining factor, as the skin must be completely desiccated before being worked. However, the finer skins (skins of small animals, skins of stillborn deer) are not worked on frames of such a large size and the immobilisation of the group would not be necessary in this case (Audouze and Beyries 2007; Beyries and Rots 2008a; 2008b).

CONCLUSION

A detailed analysis of the traceological criteria on the tools with working edges used to scrape skins provides access to rich archaeological interpretations that enable access to certain aspects of the technical systems and of the mobility. For example, the highlighting of the work of large skins on a very large frame means that the craftsmen will be immobilised for a number of days and even weeks. To access such information, even partially, a perfect understanding of the material and the underlying rules of a technical process are necessary; the current models emphasize in fact that there exists an assemblage of unavoidable rules for the *chaîne opératoire* in the working of skins. Particular attention should be paid to the state of the material worked: a dry skin should not have any elasticity and only when desiccated is a segmentation of the production process possible, transport possible (especially when large in size) and the mobility of the human group conceivable. It must not be lost from view that skin is a living organic material and that environmental variables influence the choice of process, as well as the adaptation of the work to the advancement of each stage.

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