Use-wear and residue analyses of ground slate tools from Stone Age northern Norway

Methodology and overview of results

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Ground slate knife from Bårvik, Hasvik in Finnmark. (Photo: M. Karlstad, UMAK)

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Summary

In 2018–2019 197 ground slate tools from northern Norway, traditionally referred to as slate knives and dated to the Stone Age, were analysed to investigate their original use. This was done through a study of use-wear and residues on the tools.

Here we provide a thorough report on the methodology of the study, which included extensive preliminary experimentation on modern slate replicas, before scrutinising the original stone age artefacts and samples of residues under magnification.

The report also provides an overview of the results. The appendix provides details of the observations from the experiments.

Contents

Introduction

This report outlines the procedures in the analyses of ground slate tools, often referred to as slate knives, from northern Norway. The analyses of use-wear and residues were designed and conducted by Dr Carol Lentfer. The project was funded through the research group SARG at UiT The Arctic University of Norway in Tromsø. Prof. Charlotte Damm (AHR, Department of Archaeology, History, Religious Studies, and Theology) and Prof. Marianne Skandfer (UMAK, The Arctic University Museum of Norway) acquired the funding, selected the tools for the study and assisted with necessary equipment and reference material.

The examination of the tools was conducted over approx. 6 months in 2018 and 2019 at UiT The Arctic University of Norway in Tromsø, partly at the laboratory at AHR, partly at the Arctic University Museum. The following analyses of the observations was handled by Lentfer in Australia, and the report on results was completed in 2023.

The aim of the project was to investigate the extent to which it is possible through use-wear studies and residue analysis to determine **how** the original stone Age tools were used and on **what** kind of material. An overview of the results is provided here.

Tool selection

A total of 197 ground slate pieces from the district managed by the Arctic University Museum were selected for the study. 170 pieces derived from the collections at the Arctic University Museum and 27 pieces from early excavations on northern Norway, now located at the Museum of Cultural History at the University of Oslo, were also included. The selection included both whole tools and fragments. The selection aimed at covering a variety of different forms and sizes. At the outset of this research, we attempted to cover as large a geographical area as possible. However, as well documented contexts and sound provenance were required for intra- and inter-site analyses, the major portion of tools for this study derives from Finnmark County, where the most extensive excavations have taken place. This culminated in many tools being from prehistoric house sites.

To facilitate the analyses, the tools were categorized into 4 broad typological subsets:

- Lanceolate and straight blades
- Curved or angular blades
- End blades
- Bladelets

These groupings are certainly not firm. The tools should be carefully scrutinised and re-organised for ongoing analyses.

Project design overview

The project design for the analysis of use-wear and residues relies on substantial initial experimentation on replica tool edges with many different gestures on many different materials. This produced an extensive base of reference to which use-wear patterns, residue distribution and particulars of the residues on the original Stone Age tools could be compared. An extensive modern selection of animal hairs from species common in northern Norway was also available for comparison.

The selected Stone Age tools were photographed and drawn before lightly rinsing with distilled cold water. They were then examined under magnification for use-wear and residue traces, which were recorded, photographed and marked on the drawings. Where possible, samples of residues were collected for more detailed examination. For details of the procedures, see below. The recorded use-wear and residues were then compared to observations on the experimental tools for interpretation. All observations and interpretations were recorded in excel-sheets.

Lentfer had no prior knowledge of the archaeology of northern Norway and was not given information on previous interpretations of slate tool use. She was not informed of the provenance of the tools (e.g. coast or inland) of the selected pieces. These precautions were taken to limit biases in the study. She was of course aware of primary available resources in the region during the Stone Age: large ungulates (reindeer, elk), marine mammals (notably seals) and fish.

Experimentation

A fundamental and very important procedure of this investigative research was experimentation. Replicas of slate tool edges were made and used with a variety of gestures and on a range of different materials.

Slate sourced from sites in Finnmark was used for the experiments. Edges of chipped slate fragments were ground and sharpened with sand and water on schistose grindstones. Pumice was sometimes used for final smoothing and sharpening. Prior to the experimental tools being used, the sharpened edges and surfaces were washed in distilled water and examined using Low Power and High Power reflected light microscopy (see description of equipment below in section on Analytical procedure). Each tool was drawn on record sheets and digital images of edges and surfaces selected for follow-on experimental use were taken and recorded for post-use comparison.

The edges were then used to work on different animal and plant materials. As far as possible materials that may have been exploited by prehistoric peoples living in arctic

environments were targeted. However, in some cases, substitute materials were used (e.g. fresh pig meat rather than fresh ungulate meat, dry lamb meat instead of dried ungulate meat, fresh cow bone rather than fresh ungulate bone). In total 20 different types of material, some fresh and others dried, were included in the experiments (Table 1). Birds were not included in the experiments. Similar to hair fibres, feather components can be well-preserved and there would still be a possibility of identifying bird residues on prehistoric tools.

Table 1. Materials on which experiments were performed.

Harp seal	**Reindeer**	**Fish**	**Pine**
Hide inner (fresh)	Hide inner (fresh)	Flesh with skin	Root (wet)
Hide outer (fresh)	Hide outer (fresh)	Flesh, skin and bone	Resin on bark
Hide inner (dry)	Hide inner (dry)	Scaly skin (fresh)	Inner bark
Hide outer (dry)	Hide outer (dry)		
Hide and blubber			
Blubber			
Pig	**Lamb**	**Cow**	**Birch**
Flesh (fresh)	Flesh (dry)	Bone (fresh)	Bark

Sharpened edges of experimental ground slate pieces were used in a variety of gestures including cutting, slicing, scraping, and scaling. In all, ten types of use gestures were used:

- Cutting (1 direction towards user) – the cutting edge perpendicular to worked material
- Slicing (1 direction towards user) – similar to cutting but the tool is held at an angle to the worked material so that the dorsal or ventral face has more contact with the worked material
- Slicing (backwards/forwards) – the tool used at an angle to the worked material so that the dorsal or ventral face has more contact with the worked material
- Sawing (backwards/forwards) - the cutting edge perpendicular to worked material
- Scraping (towards user)
- Scraping (away from user)

- Scraping (scaling tail to head)
- Scraping/gouging
- Shaving (towards user)

The combination of material and gestures resulted in 31 experimental categories. For a comparison of use traces versus use period, each experimental category was repeated three times each with fresh unused edges of tools - for five minutes, 20 minutes and one hour durations. This culminated in 93 experiments altogether. Tool efficiency was recorded for each experimental category, and residue distribution and types and patterns of use-wear before and after washing in distilled water were recorded for all experimental pieces used for 1 hour. The first washing of experimental pieces did not remove all residues from tools. Hence, some use-wear features were obscured. More thorough washing will enable further clarification. Notably, before washing, selected residues were sampled, mounted on microscope slides with water and examined with transmitted light microscopy. This body of information was key for the interpretation of the Stone Age tools. For more details of the observations from the experiments see appendix in this report.

Experimental results: tool efficiency

Use efficiency varied according to obvious characteristics, such as tool size and ease of handling, edge sharpness and edge fragility. But taking such differences into account there were overriding differences in tool working efficiency due to different materials and use-gestures (

Table 2).

Sharpened slate edges are most effective for working soft materials such as flesh and soft bark, rather than firmer materials such as hide and harder materials such as woody bark and bone. No matter what the gesture, whether cutting, sawing, slicing, scraping or shaving, the patterns of efficiency are much the same. This helps us to see that slate is very suitable for skinning and butchering marine mammals and preparing their skins, but it would have been equally efficient for skinning and butchering reindeer, processing hides of terrestrial animals, as well as processing fish and cutting and scraping soft vegetable matter. Thus, having good multifunctional capability, there is some support for the notion that slate tools could well have been used for a wide variety of tasks, and not merely confined to tasks associated with processing marine mammals, as has often been assumed.

Table 2 Experimental tool efficiency. green: very efficient; yellow: moderately efficient; red: inefficient

Cutting	**Scraping (towards user)**	**Scraping (away from user)**	**Sawing**	**Shaving (towards user)**
Seal blubber	Seal hide inner (fresh)	Seal hide inner (fresh)	Seal blubber	Seal hide outer (fresh)
Pig flesh	Reindeer hide inner (fresh)	Reindeer hide inner (fresh)	Pig flesh	Seal hide outer (dry)
Pine root	Cow bone (fresh)		Fish flesh and bone	Reindeer hide outer (fresh)
Dried meat	Pine root		Pine root	Reindeer hide outer (dry)
Seal hide outer (fresh)	Pine inner bark			
Seal hide inner (dry)				
Reindeer hide outer (fresh)				
Reindeer hide inner (dry)				
Fish with skin				
Cutting/slicing	**Slicing**	**Scaling**	**Scraping/gouging**	**Stripping bark**
Seal hide and blubber	Pig flesh	Towards head of fish	Pine resin on bark	Birch bark
	Seal blubber			
	Fish flesh against bone			

Other comparative data

In the hope of identifying specific species of animals a large collection of hairs from numerous animals native to northern Norway was used for comparison with residue on the Stone Age tools. Hair fibre identification was based on scalar patternation. However, fibres can have similar form and scalar patterning. Therefore, hair identification sometimes requires analysis of fibre cross-sections, not possible in the current study. The identification is therefore in many cases suggestive rather than definitive. In the assessment of the tools the terms `possible´ and `probably´ are used. Using 5 levels of certainty that the worked material is a particular species, `possibly' would be 1 to 3 and 'probably' 4 to 5.

Analytical procedure Stone Age tools

All archaeological tools were initially photographed and drawn with distributions of easily visible use-wear and residue traces marked on drawings. Following this, although most of the tools had already been washed after their initial recovery during field collection procedure, they were lightly rinsed again with distilled water to remove superficial curatorial residues, prior to ongoing examination. Following this they were air-dried at room temperature, then examined for use-wear and residue traces in more detail with Low Power and High Power reflected light magnification. All use traces were recorded, photographed and marked on the drawings. Powder-free gloves were used for all stages of the analysis, although the tools had been handled without gloves prior to this study.

Following in-situ examination, samples of residue were removed from tools using polypropylene pipettes with water or immersion of tools in water inside a plastic bag within an ultrasonic bath (USB). In some cases, a scalpel blade was also used to remove thick or stubborn residue samples. All sampling locations were recorded on drawings. The residues were mounted onto microscope slides with water and examined with Transmitted Light microscopy up to x400 and occasionally x600 magnification.

Table 3 Types of analyses (LP = Low Power; HP = High Power; TL = Transmitted Light; Im = Digital imaging

Type of analysis	No. of tools
Full Analysis (LP+Im, HP+Im, TL+Im)	126
Partial Analysis 1 (LP+Im, HP, TL+Im)	44
Partial Analysis 2 (LP, TL+Im)	27

Due to time restraints and problems with the reflected light microscope being damaged in transport, not all artefacts received the same degree of scrutiny in the initial in-situ examination procedures (see Table 3). Of the 197 artefacts, 126 were examined using Low Power (LP) and High Power (HP) in-situ microscopic analysis with imaging, and all surfaces were examined. Of the remainder, 44 were examined using LP and HP in-situ analysis with LP imaging only, and 27 were examined with LP only and no imaging was undertaken. Examination focused on the Distal (D) and Medial (M) surfaces, not on the M to P surfaces (i.e.) handles or stems (if present). Transmitted light microscopy (TL) was used to examine all sampled residues.

A Nikon low power optical microscope (LP) with a maximum of x80 magnification and a Nikon high power (HP) mineralogical microscope with a maximum of x400 magnification were used. A Lumenera INFINITYX-32 pixel shifting microscope dedicated camera was

used for in-situ imaging. An Olympus BH microscope and Nikon 995 Digital camera were used for the TL microscope analyses and imaging.

Comparative collections of modern experimental ground slate tools and hair fibres, as described above, were used to assist with identification of gestures and residues relating to tool use.

Overview of Results

This report focuses on use-wear and residue traces on blade surfaces, not handles. Wear traces and residues were very well-preserved and clearly visible on most tools, with wear traces observed on 167 pieces and use-related residues present on at least 136 (see tables 4 and 5).

Table 4 Use-wear traces recorded. (N/A means not analysed due to tools being preforms, too damaged or weathered, or too contaminated).

Use-wear traces	**No. of tools**
Present	167
?	11
Absent (N/A)	19

Table 5 Residue traces recorded, including residues observed with in-situ and TL analyses.

Residue traces	**No. of tools**
Present	136
?	20
Absent	10

Tool function

Within the stone tool assemblage examined, curved or angular blades are by far the most numerous, followed by lanceolate and straight blades, then bladelets. Least numerous are the end blades (Figure 1).

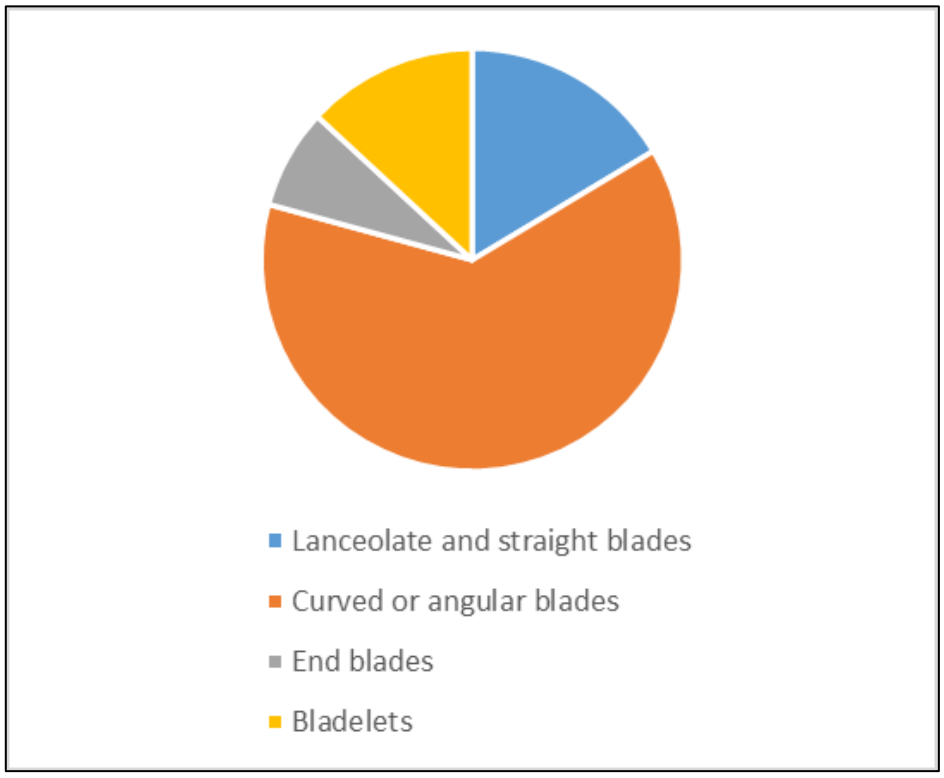

Figure 1 Typological subsets of the tool assemblage analysed

Lanceolate and straight blades

This assemblage includes large robust double-edged knives, a couple with serrated edges, and smaller double-edged and single-edged pieces. The majority have use-wear traces typifying cutting and cutting/slicing gestures but sawing and scraping traces were also observed on a few of the blades (Figure 2). The majority were used for processing fish, cutting and slicing both dried and fresh material. Use-wear and residue traces suggest that some knives were used as general-purpose knives, i.e. for processing several different animal resources e.g., cutting both fresh and dried material of both fish and mammal species, including seal (Figure 3). Others appear to have been used more specifically e.g., for butchering and/or skinning seal, reindeer and possibly otter. One tool appears to have been used for cutting fresh hide on a wooden base.

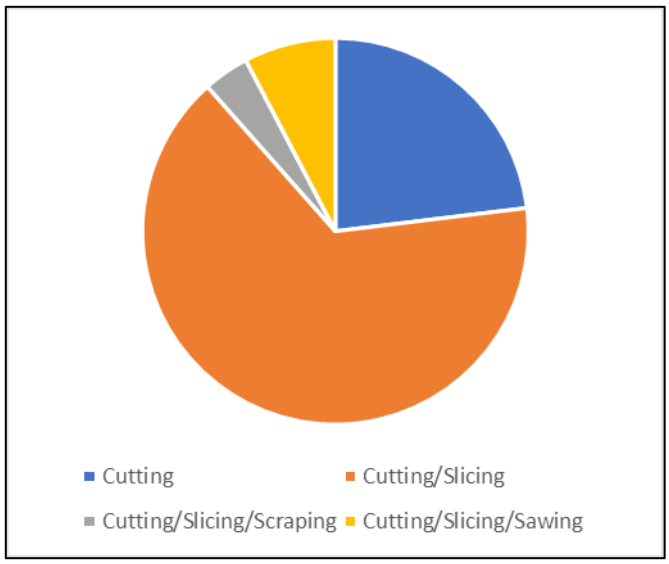

Figure 2 Gestures used with lanceolate and straight blades.

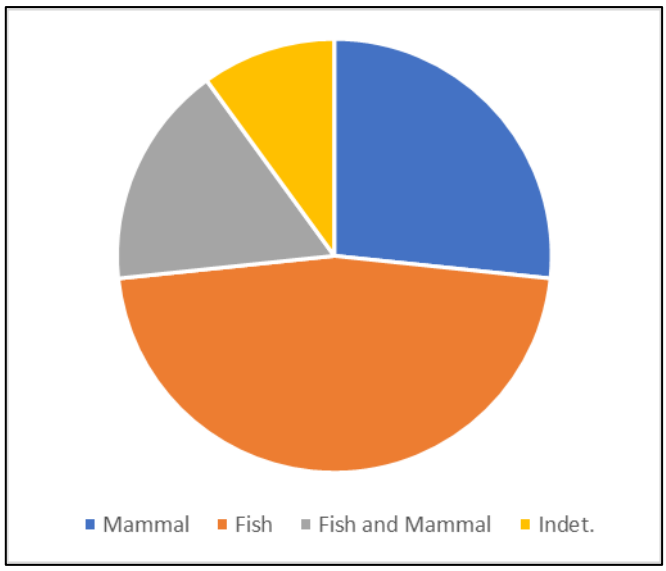

Figure 3 Materials worked with lanceolate and straight blades.

Curved or angular blades

This assemblage comprises a variety of typologies, including large, robust pieces with long, broad handles, smaller curved and angular knives, mostly with pronounced handles that would have been hafted, and similar blades with pronounced heels and handles. Use-wear and residue traces show that these tools had a variety of functions (Figure 4 and Figure 5). The majority were used for working with mammal material and have use traces showing they were used for cutting/slicing gestures typical of butchering and/or skinning. Most have traces of hair cf. reindeer, and to a lesser extent, others have hair more like

that of seal. Some were possibly used for both reindeer and seal. Traces of hair from Arctic fox, otter, and possibly sheep were also identified.

Knives that appear to have been used primarily for cutting are also well represented and a relatively small number have wear patterns typical of sawing and scraping. Residue traces show they were used for cutting both fresh and dry hide, including hide of reindeer, seal, and other species including otter and possibly squirrel, marten and Arctic fox. Other tools were used for cutting both fresh and dried animal flesh, unspecified. Only four blades have evidence for processing fish.

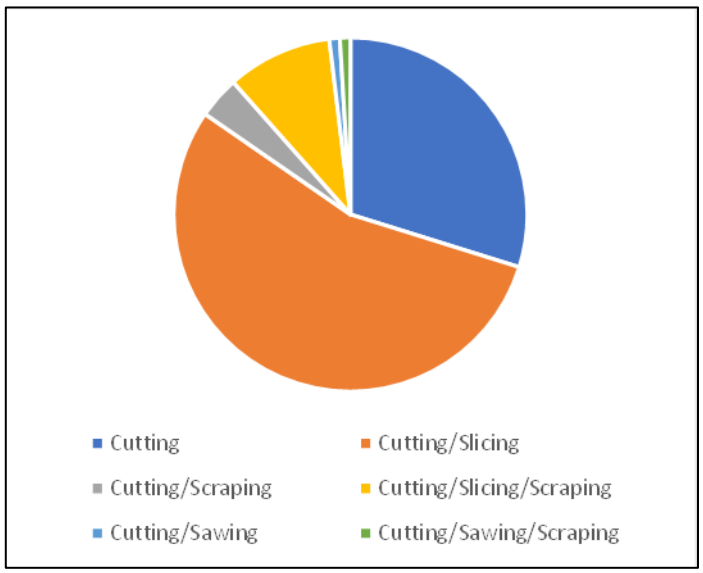

Figure 4 Gestures used with curved or angular blades.

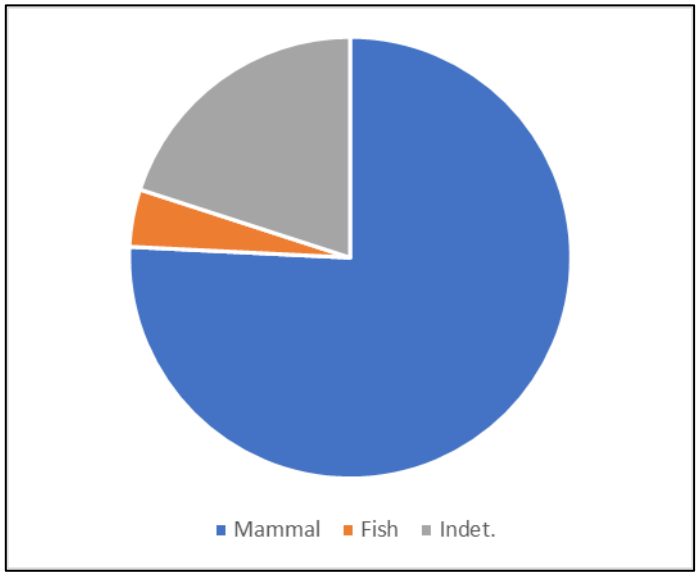

Figure 5 Materials worked with curved and angular blades.

End blades

These tools have various forms, but all have a distal blade edge more-or-less perpendicular to the handle or distal-proximal axis. Both robust and smaller tools are represented. Several have T-shaped or flared convex blades with handles and there is one rectangular tool with a slightly convex distal edge. Most have use traces typical of cutting and scraping, but a few have traces typical of either scraping, cutting, cutting/slicing or cutting/slicing/scraping (Figure 6). Residue traces show that the majority were used for processing hide, including reindeer, otter and smaller mammals such as fox, mink or rodent. There is evidence for both fresh and dried material being worked. Some may have been used for cutting flesh as well. One appears to have been used for butchering reindeer, and one was used with fish (Figure 7). Presence of starch and plant fibres in some residue samples is suggestive of material being worked on a wooden base, possibly pine.

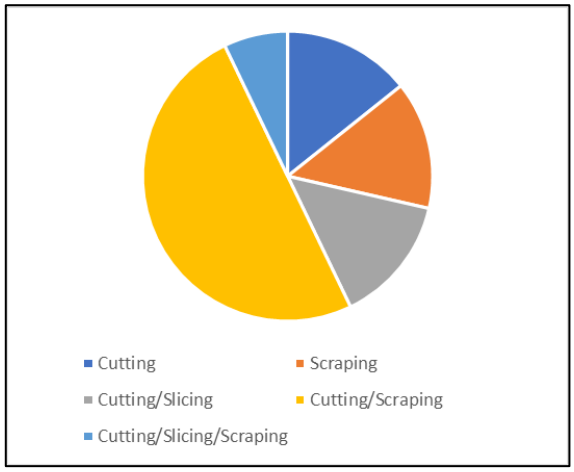

Figure 6 Gestures made with end blades.

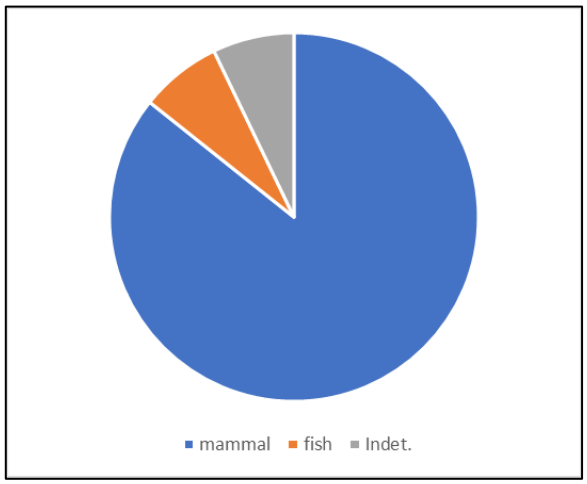

Figure 7 Materials worked with end blades.

Bladelets

This group is represented by very small curved or angular blades, including boot-shaped blades with heels. More than half of these small blades showed good evidence of being worked, mostly for cutting, cutting/scraping and cutting/slicing (Figure 8). Residue traces, including hair fibres, blood-like residue and possibly skin/hide residue, were found on the majority. This combination of evidence shows that they were used for processing small mammals including rodent species such as vole (Figure 9). Use-wear traces suggest that some may have been used for skinning, others for cutting dry hide and/or animal flesh. There is evidence that one tool was used for cutting dry hide of reindeer. Starch granules and fibres suggest the use of wooden cutting boards.

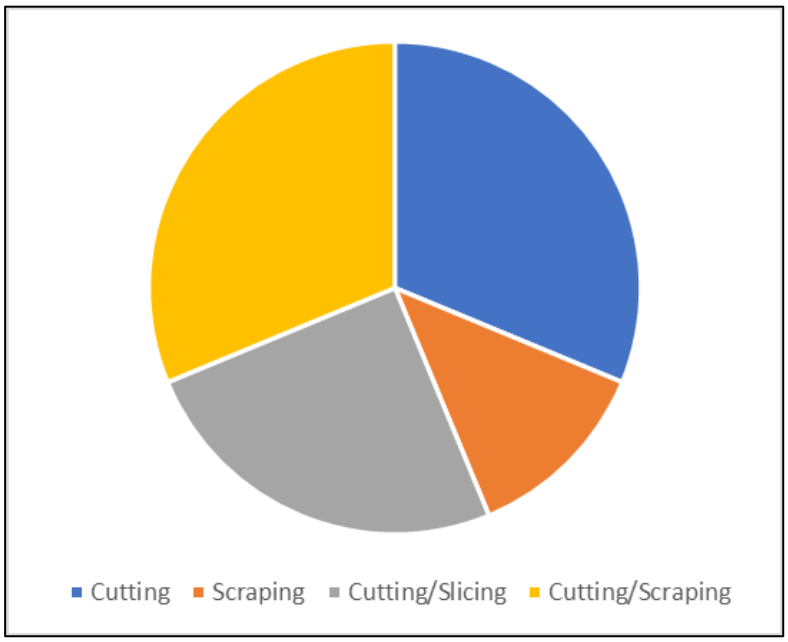

Figure 8 Gestures made with bladelets.

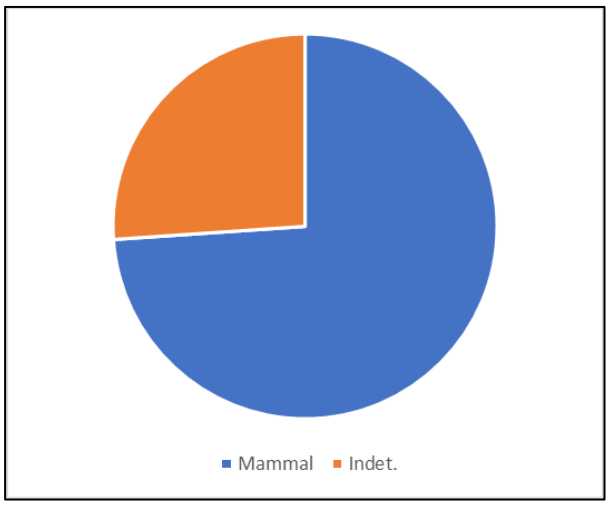

Figure 9 Materials worked with bladelets.

Re-sharpening

Manufacture of slate knives, particularly the grinding process to shape the overall tool and sharpen blade edges, would have involved considerable time and effort. As such, it is probable that they would have been much valued items in Arctic tool kits. The edges, particularly if used on hard, tough materials such as hide and bone, would have been subject to fracturing and blunting, hence requiring regular maintenance involving re-sharpening and re-shaping. This is evident from this analysis, where striae indicative of re-sharpening were recorded on at least 20 tools.

Further Comments

- This study shows that slate tools were used for a variety of tasks.
- Different tool types were used for different tasks.
- Some tools were used for multiple tasks.
- Slate tools were primarily used for animal working, mammals and fish.
- There is no firm evidence for slate tools being used for plant working.
- Starch granules and plant fibres were often present in residues. These may be environmental or post-excavation contamination. However, the starch granule morphology concurs with Pinus sp. suggesting that starch may have been derived from cutting boards. Further investigation is needed.
- There appears to be a positive correlation between presence of blood residue, indicative that tools were worked with fresh material, and presence of fungal hyphae. Fungal hyphae could therefore be indicative of working with fresh animal material. Further investigation is needed to confirm this.
- There is a positive correlation between tool size and size of animal – large tools were more likely to be worked with large animals, and small tools, with small animals.
- There is evidence for small curved bladelets being used to work animals possibly as small as voles or mice. They may have been used by children for skinning, but just as likely used for processing fine hide for production of soft clothing, pouches and other soft material items.
- Scanning election microscopy and biochemical analyses of associated residues, as undertaken for the large skinning knife Ts.10927 (Lentfer et al. 2023) might yield more definitive identification.
- Further clarification of use-wear may come from continuing the analytical process. This would involve washing all residues from blade surfaces and re-examination of tools using HP microscopy.

- Further clarification would come from expanding experiments to include more gestures, longer working times for experimental tools, and working with more types of material.

Postscript

This report is primarily based on a report finalised in 2023 by Carol Lentfer. Details on the tool selection and the experimentation have been added for a fuller report on project design and procedure.

The overview of results reported here is based on 197 knives. A later scrutiny of the included tools discovered that three tools were listed twice. Hence later publications will refer to 194 tools. This however does not affect the general overview of the results originally reported by Lentfer.

Supplementary information

The dataset is available through Carol Joy Lentfer, 2025, "Background Data for Use-wear and Residue Analyses of Ground Slate Tools", https://doi.org/10.18710/B7LPBD, DataverseNO

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REFERENCES

Lentfer, C. J., Skandfer, M. Presslee, S., Hagan, R., Robson, H.K. and Damm, C. 2023. Cut above the rest: A multi-disciplinary study of two slate knives from forager contexts in coastal Norway. *Oxford Journal of Archaeology*, 42(2), 90-106. https://doi.org/10.1111/ojoa.12267

Lentfer, C.J. 2025. Background Data for Use-wear and Residue Analyses of Ground Slate Tools, https://doi.org/10.18710/B7LPBD, DataverseNO

Appendix

Slate tool experiments on replica edges. Summary of residues and use traces.

Carol J. Lentfer

HARP SEAL

Blubber	*Cutting:* Fatty residue smeared over entire tool with blood vessels, tissue fragments and some hair fibres along cutting edge and margins. Edge rounding, smoothing and polish along cutting edge. Small bending fractures along cutting edge with feather and some step terminations. Steeper edges on surface asperities facing towards cutting edge in direction of force. Striae run parallel to cutting edge. *Slicing (backwards/forwards, Ventral side downwards):* Similar residue distribution to cutting but fewer hair fibres and tissue fragments. Smoothing, etching of inner surfaces with polish. Pecking and bending fractures along cutting edge. Most edge fractures with ventral initiation. *Sawing:* Residue distribution similar to cutting gesture with highest density where tool was held. Lineal deposits of fatty residue along used edge and margins. Fibres aligned parallel to working edge. Rounding and smoothing of working edge with pitted polish. Grinding striae smoothed and etched from use.
Inner hide (fresh)	*Slicing (one direction/skinning - Ventral surface against hide):* Oily/fatty residue with sinew over entire tool surface. Tissue accumulation most dense along proximal margins of cutting edge and under thumb position where tool was held. Rounding, pecking, well-developed polish with pitting along working edge and margins. Bending fractures along edge mostly with ventral initiation. Steeper edges of surface asperities towards cutting edge in direction of force. *Scraping (towards user - Ventral side downwards):* Residue accumulation behind lip of working edge but entire tool coated in oily/fatty residue. Fibrous tissue deposits on both sides of the convex distal edge where contact was less. Residue compressed onto surface where tool was held. Rounding and etching of ventral contact edge and margin. Small edge fracture scars with dorsal initiation and smoothing of grinding striae.

	Steeper edges of striae face working edge. No etching or wear of grinding striae along dorsal margins of working edge. *Scraping (away from user - Ventral side downwards):* Similar residue and use-wear to scraping towards user. Oily/fatty residue with some hair fibres over entire tool surface. Polish developed along working edge extends to ventral margin. Pecking along edge and bending fracture scars with dorsal initiation. Edges of asperities and grinding striae steeper towards direction of force i.e. the scraping edge. Dorsal edge smoothed but no smoothing or polish on inner edge. Also, increase in size or original fracture scars on dorsal edge from grain removal due to force.
Inner hide (dry)	*Cutting:* Oily residue with skin and bundles of tangled hair fibres along working edge. Edge rounding, pecking and small bending fracture scars with feather or step termination and either dorsal or ventral initiation. Some fracture scars penetrate into margins. Dorsal and proximal sides of fracture scars are steep. Polish well-developed along working edge and inner edges with well-smoothed surfaces. Grinding striae along edge are etched.
Outer hide (fresh)	*Cutting:* Whole tool covered in oily/fatty residue and hair fibres. Residue compressed onto surface where tool was held. Grinding striae along cutting edge and inner margins etched resulting in deeper profile compared to striae on unworked tool. Smoothing, rounding and polish along cutting edge to inner margins, most pronounced on distal end. Pecking along cutting edge and bending fracture scars mostly with dorsal initiation and feather termination. *Shaving (Ventral side downwards):* Entire tool covered in oily/fatty residue and hair fibres but most accumulation on dorsal surface. Tissue compressed onto surface where tool was held. Very distinct edge rounding and several new fracture scars with dorsal initiation. Asperities and original grinding striae along ventral edge to inner margin worn and smoothed with steeper sides facing towards direction of force i.e. towards working edge. Rounding of dorsal edge but no wear on surface beyond edge.
Outer hide (dry)	*Shaving (Ventral side downwards):* Tissue fragments and torn hair fibres accumulated along working edge and on dorsal surface. Very little residue on ventral surface but working edge rounded, well-smoothed with polish. In contrast, there are no use-wear traces beyond inner margin of ventral surface and none on dorsal surface. Grinding striations still visible along ventral working edge but etched. Steeper edges of striations and asperities

	face working edge. Bending fractures along edge mostly with dorsal initiation.

PIG

Flesh (fresh)	*Cutting:* Torn tissue, sinew, fibres and fatty residue scattered over dorsal and ventral surfaces but most prevalent along used distal to medial working edge and where tool was held. Edge rounding very prominent along distal to medial edge where most pressure was applied. Smoothing of grinding striae and asperities on distal to medial surfaces but most pronounced along the edge and inner edges. Edge fractures from use not obvious. One bending fracture scar with feather termination and dorsal initiation is well-smoothed and original fracture scars with step termination well-smoothed from use. *Sawing:* Fatty residue with torn tissue, sinew and fibres over entire tool with most accumulation along working edge. Rounding and smoothing (blunting) of working edge with original fracture scars and grinding striae well-smoothed. Smoothing extends to inner dorsal margin indicative of tool being worked by left hand and held at a slight angle. *Slicing (backwards/forwards, Dorsal side downwards):* Entire surface coated in fatty residue with torn tissue fragments. Denser accumulation on dorsal surface where there was more contact with worked material. Residue accumulated in original fracture scars along edge but denser accumulation on inner surfaces than edge. Small amount of surface smoothing and rounding of edge. Grinding striae etched. Steeper sides of grinding striae and asperities face working edge. Use related fracture scars not observed.

COW

Bone (fresh)	*Scraping (flesh off bone - Ventral edge against bone):* Fatty residue with sinew and other tissue including bone accumulated along working edge. Also deposited on inner surfaces including where tool was held. Edge rounded. Smoothing and polish confined to working edge and inner ventral edge. Asperities smoothed with steeper sides facing working edge. Fracture scars along entire working edge with dorsal initiation and step termination. Pecking of granular particles from working edge common. No wear traces on dorsal surface.

LAMB

Flesh (dry)	*Cutting:* Residue along working edge and compressed onto surface where tool was held. Edge rounding and smoothing with some pecking. Very small bending fracture scars all with dorsal initiation indicative of right-handed working. Most scars have feather termination. Grinding striae adjacent to edge well-smoothed. Polish along edge and outer edges. Very fine striae run parallel to outer working edge.

REINDEER

Inner hide (fresh)	*Scraping (towards user - Dorsal side downwards):* Fatty residue with torn tissue and fibres including hair wrapped over working edge and extending to margins of ventral edge with distal-proximal orientation. Edge rounded and smoothed with pecking. Inner and outer dorsal edge also well-smoothed with distal-proximal orientated striae and some polish development. Small bending fractures along edge have ventral initiation and shallow step or feather termination. Steeper sides of asperities face working edge. *Scraping (away from user - Ventral side downwards):* Residue and use-wear traces much the same as results for scraping hide towards user but with residue distributed more on dorsal surface. Small fracture scars along working edge mostly with dorsal initiation and very shallow step or feather termination.

Inner hide (dry)	*Cutting:* Residue with torn tissue, skin cells and fibres including hair fibres compressed along cutting edge. Residue is compressed much more so than from shaving. A small amount of residue extends to margins and is aligned parallel to working edge, but some aligned perpendicular to edge. Edge rounding and pecking with thick polish development. Lineal striae run parallel to edge. Smoothing of asperities close to working edge and traces of grinding striae very well-etched.
Outer hide (fresh)	*Cutting:* Skin tissue with hair fibres accumulated mostly along cutting edge but extends to inner edges and margins. Residue also accumulated on edge proximal to cutting edge. Rounding and polish along cutting edge. Very fine lineal striae on inner edges run parallel to edge. Pecking and very small fractures along edge mostly with distal initiation, feather or shallow step terminations. *Shaving (Ventral side downwards):* Hair fibres and tissue abundant and wrapped over working edge - some adhered to inner ventral inner edge. Slight polish along dorsal edge with skin tissue and smoothing on outer edge. Ventral inner edge and margin very well-smoothed with pecking mostly with dorsal initiation. Numerous edge fractures mostly with dorsal initiation, and shallow step or feather termination.
Outer hide (dry)	Shaving *(Ventral side downwards):* Tissue fragments and torn hair fibres, mostly fragments, prevalent and compressed along working edge. Residue aligned perpendicular to ventral edge but comparatively little along margins and inner ventral surface. Tissue and hair fragments also prevalent on along dorsal side of edge and much denser accumulation along margins and dorsal inner surface. Rounding, smoothing and polish along edge and ventral contact surfaces from outer edge to inner margin. Grinding striae and asperities are smoothed with steeper sides facing direction of force i.e. the working edge. No smoothing or polish development on dorsal surface. Traces of fracture scars related to use not observed. Original fracture scars along working edge well-smoothed.

FISH

Flesh with skin (fresh)	*Cutting:* Residue with scales, blood, fat and tissue over most of tool surface. Patchy coverage where tool was held. Rounding, smoothing and polish along edge with very small fracture scars and pecking. Grinding striae etched. Smoothing of asperities along outer edge. *Scaling (tail to head of fish - Ventral side downwards):* Residue with scales, some blood, tissue and fat over entire surface but patchy where tool was held. Rounding and smoothing on ventral and dorsal sides of edge with pecking and polish development. Rock mineral particles smoothed with small amount of pitting. Smoothing of both ventral and dorsal inner edges with the steeper sides of asperities having pecked surfaces which face working edge. Minimal etching of grinding striae. Other striae aligned perpendicular to edge. Fracture scar on ventral edge with dorsal initiation.
Flesh, skin and bone (fresh)	*Sawing: (removing fish head):* Scales, bone, tissue and fatty material over entire tool but less along edge and inner edges. Bone residue smeared along edge with polish. Rounding and smoothing of working edge. Dense pitting along edge and inner edges. Original fracture scars along edge well-rounded. Asperities smoothed with steeper sides facing working edge. Etching of grinding striae. Small fracture scars along edge well-smoothed. *Slicing (backwards/forwards filleting - Ventral side downwards):* Residue with scales, blood, tissue and fatty material over entire surface of tool. Pronounced lineal deposits on ventral surface are associated with protrusions on stone surface especially on inner margins. These are aligned parallel to working edge and are from contact with fish bone. They are absent on dorsal surface. Ventral edge is smoothed and rounded, less so on dorsal side of edge. Smoothing extends across inner tool surfaces but more-so on ventral surface. Grinding striae pitted and smoothed with steeper sides facing working edge. Polish development along edge. Fracture scars along dorsal edge with ventral initiation.

PINE

Root (soft)	*Cutting:* Distinct lineal accumulation of sticky residue with tissue, fibres, and starch granules along inner ventral and dorsal margins of working edge. Smoothing, rounding, and polish of edge. Smoothing along inner edge surfaces but more intense on dorsal face due to being held by the right hand. Edge fracture scars with either distal, proximal or dorsal initiation associated with edge rounding, smoothing and pronounced polish. Fracture scars along edge with dorsal and ventral initiation and mostly step termination. Lineal striae occur along inner edges. *Sawing:* Woody residue similar to cutting residue. Aligned in thick lineal deposits along ventral and dorsal sides of cutting edge. *Scraping (Dorsal side downwards):* Residue with plant fibres and sheets of cellular tissue, starch granules and exudate accumulated along working edge and dorsal and ventral surfaces, but more residue of scraped material on ventral surface. Fibrous residue along ventral edge aligned perpendicular to edge and fixed in sticky exudate. Fibres, other tissue and exudate aligned parallel to dorsal edge. Grinding striae along edge very well-smoothed. Edge rounding and small striae perpendicular to working edge.
Bark	*Scraping (stripping bark - Ventral side in contact with bark):* Sticky resinous residue with fibres and cellular tissue wrapped over working edge with distal to proximal alignment. Edge rounded, ventral contact surface smoothed and grinding striae well-etched. Dorsal surface and grinding striae not worn. Working edge pecked from particulate removal. Fracture scars along edge with ventral initiation. Tool needs to be re-cleaned of residue and re-examined.
Resin on wood and bark	*Scraping/gouging (ventral side facing wood and bark):* Resinous residue accumulated along working edge and dorsal and ventral margins and compressed onto surfaces where tool was held. Edge rounding, large and small fracture scars prominent along edge mostly with dorsal initiation. Tool needs to be re-cleaned and re-examined.

BIRCH

Wood and bark	*Cutting: (cutting and stripping bark - Dorsal side against wood):* Thick sticky residue with sclereids, torn fibres, cellular tissue and starch granules along working edge extends to outer ventral and dorsal inner edges. Edge well-rounded with polish and fracture scars mostly with dorsal initiation and step termination smoothed from use. Fine striae aligned parallel to edge with some pecking of edges from removal of granular particles.