Skaill knives from the Ness of Brodgar: an experimental pilot study exploring their potential for functional and technological analysis

Dikkenberg, L. van den; Lyons, J.; Foley, T.; Fitton, L.; Card, N.; Edmonds, M.; Little, A.

Skaill knives from the Ness of Brodgar: An experimental pilot study exploring their potential for functional and technological analysis

Lasse van den Dikkenberg [1], Jacob Lyons [2], Tom Foley [2], Laura Fitton [3], Nick Card [4], Mark Edmonds [3], Aimée Little [2]

1. Leiden University, Faculty of Archaeology, Department of Archaeological Sciences, Material Culture Studies. Van Steenis building, Einsteinweg 2, Leiden 2333CC, The Netherlands. Email: l.van.den.dikkenberg@arch.leidenuniv.nl
2. Centre for Artefacts and Materials Analysis and the YEAR Centre, Department of Archaeology, University of York, Wentworth Way, Heslington, York YO10 5DD, United Kingdom. Email: Lyons: lyonsj19@gmail.com; Foley: tomfoley2001@gmail.com; Little: aimee.little@york.ac.uk
3. University of York, Department of Archaeology, Hull York Medical School, Wentworth Way, Heslington, York YO10 5DD, United Kingdom. Email: Fitton: laura.fitton@hyms.ac.uk; Edmonds: edmonds@york.ac.uk
4. University of the Highlands and Islands, Archaeology Institute, UHI Orkney, Kirkwall, Orkney KW 15 1LX, United Kingdom. Email: nick.card@uhi.ac.uk

Abstract:

This paper presents the results of a pilot study exploring the biographies of Skaill knives from the Neolithic site of Ness of Brodgar (UK). Skaill knives are large sandstone flakes made from beach cobbles. We present an experimental study in which we replicated and used Skaill knives. A selection of ten archaeological Skaill knives was subjected to a detailed technological and functional analysis. Functional analysis of the experimental and archaeological tools was conducted both with a low power stereomicroscope and a high-power metallographic microscope. 3D models of the archaeological Skaill knives were made to better understand and visualise technological features and use-wear traces. These observations allowed us to link the flaked cobbles, frequently found in Neolithic Orkney, to the *chaîne opératoire* of Skaill knives. Regarding the production process, we were able to demonstrate that it seems likely that at least some of the Skaill knives were produced using bipolar percussion. Contrary to what was hitherto assumed, it seems unlikely that the Skaill knives were produced by dashing the stones on rocks, as the archaeological evidence points towards a more controlled method of production. The experimental work generally resulted in little to no polish development, but macroscopic features such as edge rounding and edge removals frequently occurred. The archaeological Skaill knives displayed diverse use-wear traces. Certain zones displayed heavy unifacial rounding, which most likely resulted from a scraping motion on an abrasive material. Other zones displayed extensive edge removals, which could either be linked to butchering activities or to contact with harder materials. Morphologically, these traces appeared to be linked to different zones on the Skaill knives.

Journal of Lithic Studies (2025) vol. 12, nr. 1, 30 p. DOI: https://doi.org/10.2218/jls.10143

Published by the School of History, Classics and Archaeology, University of Edinburgh
ISSN: 2055-0472. URL: http://journals.ed.ac.uk/lithicstudies/

The extensively rounded zones more commonly appeared on the short sides of Skaill knives, when cobbles were split lengthwise. The edge removals tended to occur on the long sides of Skaill knives which were split along the width of the cobble. Although specific contact materials could not be assigned, the study revealed interesting insights into the biographies of these tools.

Keywords: Skail knives; Neolithic; Orkney; use-wear analysis; experimental archaeology; lithics; sandstone tools

1. Introduction

This article presents a pilot study exploring the biographies of Skaill knives from the Neolithic site of Ness of Brodgar in Orkney (UK). This represents the first attempt at functional analysis on these coarse stone tools. An experimental program, undertaken at the York Experimental Archaeological Research (YEAR) Centre, was set-up to replicate Skaill knife production and the wear traces observed on archaeological examples.

Skaill knives are relatively *ad hoc* tools. They consist of a (large) sandstone flake which was generally used without further alterations (see Figure 1). Their dorsal face consists of the weathered surface of the beach cobble from which they are made. It is thought that Skaill knives were produced by throwing a cobble against another rock (Childe *et al*. 1929: 267; Clarke 1989: 16; 2006: 18; Petrie 1870: 215). Macroscopic wear traces such as edge rounding and edge removals can often be discerned on these tools (Clarke 2006; 2020). Previous experiments by Clarke (1989) indicated that these tools could have been used in butchering activities. Despite these promising results, a proper functional analysis, involving a microscopic analysis of the resulting wear traces, of these knives has so far been lacking. In this pilot study we aim to test whether it is possible to conduct use-wear analysis on simple cobble tools, presenting results of microscopic analysis, and assess whether specific types of wear can be linked to specific activities. To test this, an experimental program was undertaken. Combined, the experiments and analyses of the archaeological tools allowed us to gain more insight into the production and use of Skaill knives, identifying areas of future analytical potential.

Figure 1. Example of an archaeological Skaill knife from the Ness of Brodgar excavation (NoB’16 27654).

A sub-sample of ten knives were selected from the assemblage recovered from the Ness of Brodgar (for a detailed description of the archaeological sample see paragraph 3.2). Situated on a narrow isthmus (see Figure 2) in the UNESCO *Heart of Neolithic Orkney World Heritage Site*, the Ness is a large, deeply stratified, multi-phase complex of massive stone buildings. Spanning much of the Neolithic (*c*.3500-2300 cal B.C.E.), the site was a specialised settlement of monumental halls that provided a focus for periodic assemblies, drawing people in from across the archipelago and from further afield (Card *et al.* 2020).

After twenty years of excavation (2004-2024) the project now enters a phase of post-excavation analysis. This will include functional/wear analysis on artefacts such as axes, maceheads, spatulae and multi-hollowed cobbles (e.g. Lloyd 2024). Sandstone, siltstone and mudstone tools generally receive little attention in functional studies, with grinding stones and querns being the main noteworthy exceptions (Dubreuil & Savage 2014; Hamon & Plisson 2008; Verbaas & Van Gijn 2007). Although hammerstones, abraders, polishers and pounders have also been subjected to analyses (Hamon 2016; Hayes *et al.* 2018; Wentink *et al.* 2024; Zupancich *et al.* 2025). To date, aside from the work by Clarke (Clarke 2006; 2020), very little analytical work has been conducted on other *ad-hoc* tools from Orkney. Nonetheless, the presence of wear traces on Skaill knives has been documented in previous studies which raises the question of whether they can be linked to a specific activity or activities.

2. Methods

The technological analyses and experiments were conducted to better understand how Skaill knives were produced. The use-wear experiments and subsequent analysis were aimed at uncovering the past uses of these tools. The Skaill knives in this project were analysed using both a stereomicroscope (Olympus SZ61) and a metallographic microscope (Leica DM2500MH and an Olympus DP74). Many of the archaeological tools were too dirty to be properly analysed microscopically. These tools were first analysed under low magnifications to identify potential residues. If no residues were visible the tools were cleaned using water and detergent and put in an ultrasonic tank with detergent for 10-15 minutes. The archaeological Skaill knives were scanned using an Artec Space Spider, a blue-light surface scanner (Artec 3D 2015), and processed with Artec Studio 15 software (Artec 3D 2020). The latter was used to calculate the volume of the tools, which in turn could be used to calculate their density. The models further helped illustrate both the technological features and macroscopic wear traces. The main aim of the 3D scanning was to make the archaeological tools publicly available for future reference. Therefore, all 3D models are available as supplementary materials (see Supplementary file 1).

2.1. Experimental protocol

Experiments were conducted at the YEAR-Centre, following the centre’s health and safety protocols. The experiments consisted of two parts. One was the replication of the tools, i.e. the manufacture of Skaill knives; the second consisted of experiments in which knives were used for a variety of tasks, involving different contact materials.

All experimental tools were photographed prior to the experiments. Contact materials, motions in which the tools were used, and the duration of use, were recorded for each experiment. After use, the experimental tools were washed with water and soap and subsequently put in an ultrasonic tank with detergent for 15-120 minutes. To further remove greasy residues, the tools were wiped with alcohol or acetone.

Figure 2. Location of the Ness of Brodgar excavation on the narrow isthmus located between the Loch of Stenness in the south and the Loch of Harray to the north (provided by the Ness of Brodgar Trust).

2.1.1. Replicating Skaill knives

Nine cobbles were used in these experiments. Cobbles were collected on Orcadian beaches that were likely to have been exploited during the Neolithic (Clarke 1989: 16). Previously, it had been assumed that Skaill knives were produced by throwing a cobble against another rock (Childe *et al*. 1929: 267; Clarke 1989: 16; 2006: 18; Petrie 1870: 215). This assumption stems from the work of George Petrie who, in the 19th-century, made an early attempt to replicate these tools. He attempted to refute an earlier hypothesis by Watt, who believed these knives were produced by "*a smart, dexterous stroke with a stone held in the hand on the edge of a suitable stone resting on a large supporting stone´* (Petrie 1870: 214); essentially what we would classify as bipolar production. Unlike Petrie, Watt never ventured to test out this method. During a walk along the cliffs, Petrie noticed how his young son was breaking rocks by 'dashing' them on other rocks on the beach (Petrie 1870: 215). He proceeded to try the method himself:

"I dashed the broken stone, which I still held in my hand, on the rocks and as I confidently expected, and to my great delight, a flake was detached as good as any found at Skara. I frequently repeated the experiment, and with invariable success; and I have little doubt that such was the simple mode by which the flakes of the ancient kitchen middens in Orkney were generally obtained. To break them off with another stone wielded in the hand, would be a process both tedious and uncertain in its results. I believe a much more powerful stroke than can be given in that way is necessary to produce a notch like the one which is always made by dashing the stone on the rocks, or on another stone of sufficient size and hardness to resist the blow (Petrie 1870: 215)."

This proposed production method has generally been assumed to be correct, especially because others were also able to replicate this method, also producing similar flakes (Childe *et al.* 1929: 267). A 'powdery' crushed scar or notch at the proximal end is deemed to be a characteristic result of this technique (Clarke 1989: 16).

Our initial observations cast doubt on this hypothesis. Skaill knives are generally not round but oval. The location of the point of impact (seen on the ventral side of the artefacts) can be noted as a coordinate (see Figure 3). In our assemblage we systematically recorded the location of the point of impact, which was usually still visible. The point of impact was systematically situated on the thinner side of the cobble, where it facilitated the splitting. Skaill knives are generally made from flat oval cobbles, so rather than hitting the flat surface the impact point is located on the sides of the cobble. It is possible that this is the case because the cobbles would only split when they are hit from this position. What is remarkable is that the point of impact is, in fact, systematically located in the centre of the long side, coordinate B (N=4) or in the centre of the short side, coordinate E (N=4) of the pebble. Only in one instance is the point of impact located on the 'corner' side (coordinate A). Another artefact consisted of a broken pebble of which the flake was detached using bipolar percussion along the axis of the central fracture (see Figure 4).

The fact that the point of impact is systematically located in either the centre of the long side or the centre of the short side suggests that the location of the point of impact was predetermined. As such, it seems unlikely that these knives were produced by randomly dashing cobbles against rocks. If they are indeed produced by throwing, rather than hammering, these throws must have been coordinated, and a desired point of impact was chosen beforehand. One Skaill knife in the assemblage has two opposing points of impact (see Figure 4). Here it is clear the cobble was split using bipolar percussion. Another tool clearly displayed multiple impact points on the dorsal surface near the point of percussion from which the stone was split (NoB'16, 27654). This indicated that the stone was repeatedly hit on one side before the flake was detached. This suggests that the tool was made using handheld direct, or bipolar, percussion. The presence of 'multi hollowed cobbles' on Orcadian Neolithic sites also suggests that bipolar production was widely applied in Orkney (Clarke 2020: 228). It should be noted that other alternatives such as direct or indirect percussion might be worth exploring as well. Due to the limited time and raw materials available we however decided to focus only on bipolar percussion.

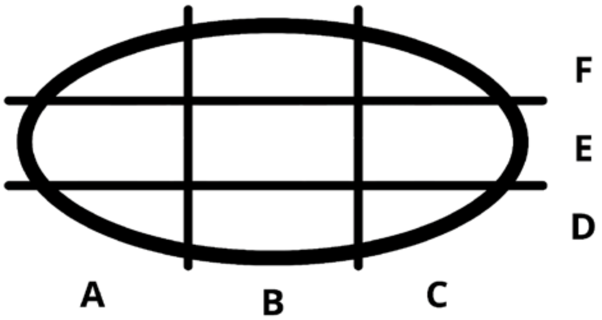

Figure 3. Coordinate system for noting the location of the point of impact on Skaill Knives.

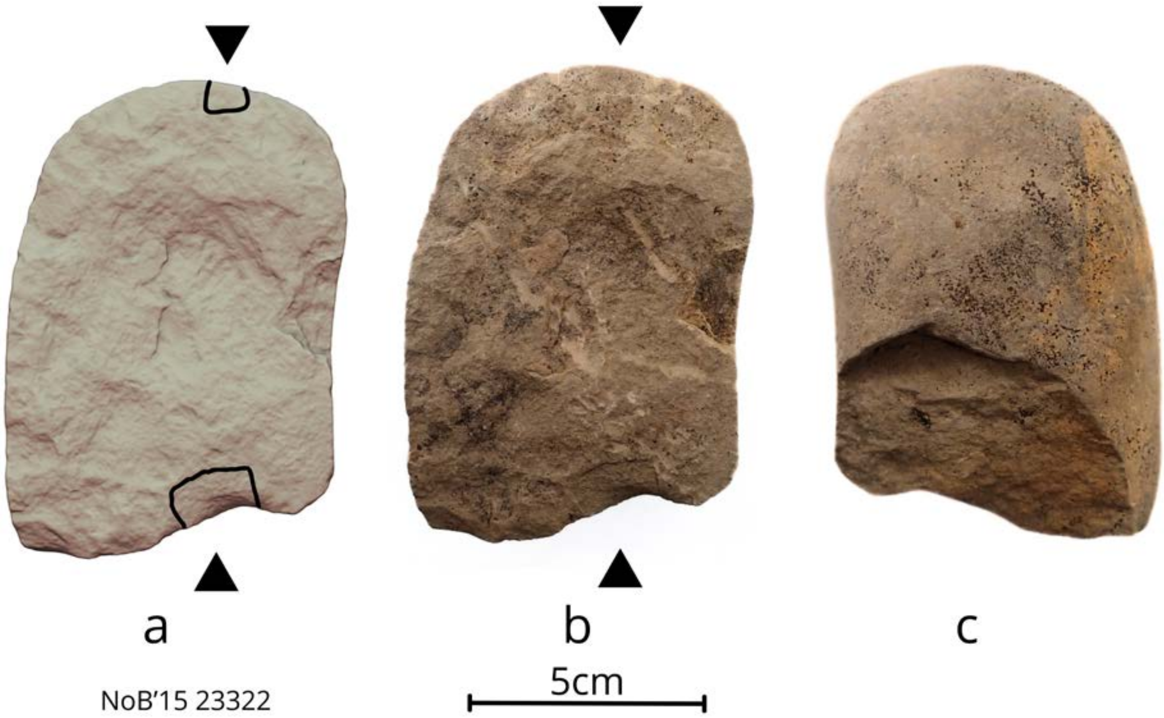

Figure 4. Skaill knife NoB'15 23322. a) Snapshot from the 3D scan, outlining the bipolar scars. b) Photo of ventral face of the Skaill knife. c) Photo of dorsal phase of the Skaill knife.

For these experiments we used sandstone and quartzite hammerstones and anvils. We used these as it has been noted that these materials were used in Orkney to make hammerstones, anvils and 'multi hollowed cobbles.' As hammerstones we used unmodified cobbles, similar to those known from Orkney (Clarke 2020).

2.1.2. The use-wear experiments

Thirteen actualistic experiments were conducted using replicated Skaill knives (see Table 1). The experiments focussed on working with animal parts (N=9), notably because butchering is most frequently cited function of Skaill knives, and because Skaill knives are frequently found in association with animal bones (Clarke 1989; Richards *et al.* 2015). Red deer bones and a red deer hide were used in the experiments, after cattle and sheep/goat, red deer is the third most common species (ca. 2% of the faunal assemblage at the site consist of red deer) found at the Ness of Brodgar (Mainland *et al.* 2020: 267-268). As we did not have access to cattle, sheep or goat parts we opted to use red deer. Although cattle would be preferable for these experiments we assume that using a different available species would not affect the development of the wear traces as previous experiments demonstrated that similar bone and hide-polishes develop regardless of the mammal species used (Keeley 1980: 44.

Table 1. Experimental tools: primary data, motion, contact material.

EXP	Length (cm)	Width (cm)	Thickness (cm)	Weight before use (g)	Motion	Contact material
A1	3.6	6	1	22.5	Carving and cutting	Fresh red deer bone
B1	2.7	6	0.5	9.2	Cutting and scraping	Meat off fresh red deer bone
C1	5.5	5.1	1	33.3	Disjointing, cutting and chopping	Meat and fresh deer bone between astragalus, calcaneum and tibia
E1	5.2	6.1	1.2	35	Disjointing, cutting and chopping	Meat and fresh deer bone between astragalus, calcaneum and tibia
F1	4.8	7.4	1.5	64.7	Defleshing, cutting and scraping meat from hide	Fresh red deer hide
F2	4.2	6.5	0.7	26.3	Cutting	Birch bark
G1	11	7	2.6	301.8	Carving and cutting	Sandstone with water
G2	4.3	6.7	0.9	26	Scraping	Soft to leather hard clay
G5	3.3	4.5	0.8	14.2	Defleshing, cutting and scraping meat from hide	Fresh red deer hide
H1	9.7	10	2.3	290.7	Defleshing, cutting and scraping meat from hide	Fresh red deer hide
H2	9.6	9.9	1.7	230	Cutting and scraping	Meat off fresh red deer bone
I1	7.9	11.3	1.8	208.2	Disjointing, cutting and chopping	Meat and fresh deer bone between astragalus, calcaneum, tibia and femur
I2	7.8	11.2	2.3	248.7	Carving and cutting	Sandstone with water

One experiment was conducted to cut birch bark strips off a fallen tree. Recent research has demonstrated that mixed woodland, including birch (*Betula sp.*) and hazel (*Corylus avellana*), was present on Orkney throughout the period (Farrell *et al.* 2014). These woodlands were exploited to provide fuel and structural timber, but it is possible that bark was harvested as well. Neolithic sites elsewhere in Europe have often shown the use of birchbark for the creation of containers (Kutschera & Rom 2000: 16; Van Regteren Altena *et al.* 1962: 31). While poor preservation makes it unclear whether bark was exploited for such purposes in Neolithic Orkney, it was decided to extend experimental work to include this material, alongside the cutting or carving of sandstone (N=2) and scraping soft clay (N=1). We chose to carve sandstone because incised sandstone objects are occasionally found in Neolithic Orkney (Saville 1994: 104-105). The use of soft clay can be related to the production of untampered ceramics, which are often used in Orkney for the production of thin walled ceramics (Jones 2001). Because of their thinness it is plausible that these ceramics were scraped to thin the walls of the pots. With these experiments we hoped to at least represent the broadest possible use-wear categories (anorganic/mineral, animal, and plant).

The experimental program was far from exhaustive, no more than a pilot to explore the efficacy of use-wear analysis on coarse stone assemblages. Experimental tools were used to the point where their working edges were no longer deemed effective for the task at hand.

3. Experimental and archaeological results

Despite the strong likelihood that Neolithic Skaill knives were made using bipolar percussion (see Figure 5), our experimental examples, made using this method, did not present bipolar impact scars. These tests indicate that bipolar percussion was possibly used to create Skaill knives, also in those instances where bipolar impact scars are lacking. However, it should be stressed that in this pilot study we have not explored alternative methods such as direct or indirect percussion. Bipolar splitting frequently failed, resulting in the detachment of both larger and smaller flakes during knapping. The impact point on these flakes can be described as a semi-circular 'notch' like those described by Petrie (Petrie 1870) (also see Figure 6). These have a powdery surface, as mentioned by Clarke (1989). This suggests that these notches cannot be directly correlated with production by 'dashing' the stones on other rocks; they can also result from bipolar hard hammer percussion.

Figure 5. Bipolar reduction to make experimental Skaill knives (photo YEAR Centre).

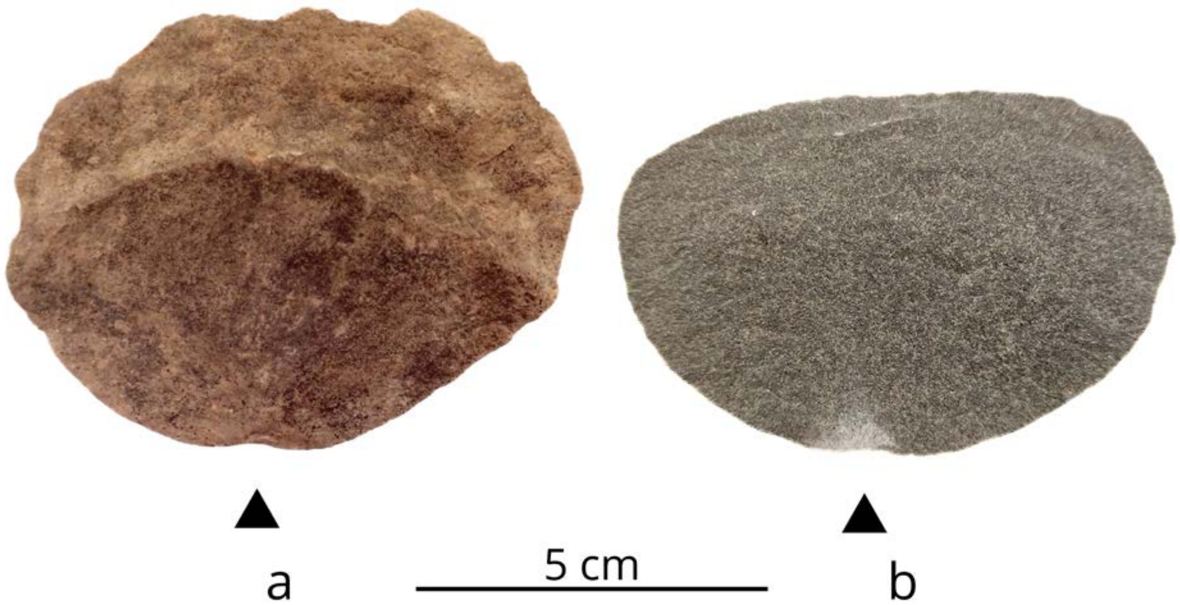

Figure 6. Dusty semi-circular impact points. a) Archaeological Skaill knife NoB’21 41576. b) Experiment F1.

Failure to cleanly split the cobble resulted in smaller flakes as well as a cobble with flake negatives. While the smaller flakes resembled small Skaill knives, the resulting cobbles are like what is classified as a ‘flaked cobble’ (Clarke 2006). Two of these cobbles were added to the experiments, their edges further retouched when necessary to provide a suitable working edge. Similarities between these cobbles and ‘flaked cobbles’ suggests that the *chaîne opératoire* of flaked cobbles and Skaill knives are entwined (see Figure 7). A *chaîne opératoire* can be defined as a repeated sequence of mental operations and technical gestures which results in the production of more or less standardised end results (Pelegrin 1990: 117; Stellet 1993: 106). It is possible that flaked cobbles were sometimes produced incidentally during the production of Skaill knives. The cobbles themselves also occasionally display macroscopic wear traces, such as rounding and abrasion, suggesting these were sometimes used unmodified (Clarke 1995: 190; 2006).

3.1.1. Experimental flake terminations

The manufacturing experiments resulted in various types of flake terminations. Feather terminations were most common, although several flakes yielded hinge and step terminations (see Figure 8). The group of feather terminations was highly varied. Some resembled typical feather terminations (see Figure 8: B1, C1, E1 F2, and G2). Occasionally, the termination suddenly bends outwards, clearly as a result from insufficient force applied (see Figure 8: F1). A similar outwards bending fracture can be observed on a decorated Skaill knife from Skara Brae (Saville 1994: 105). When the cobbles were successfully split, the termination was feathered. Here it was clear from the semi-oval profile that these were successfully split cobbles, rather than flakes detached from a core (see Figure 8: H1, H2, and I1).

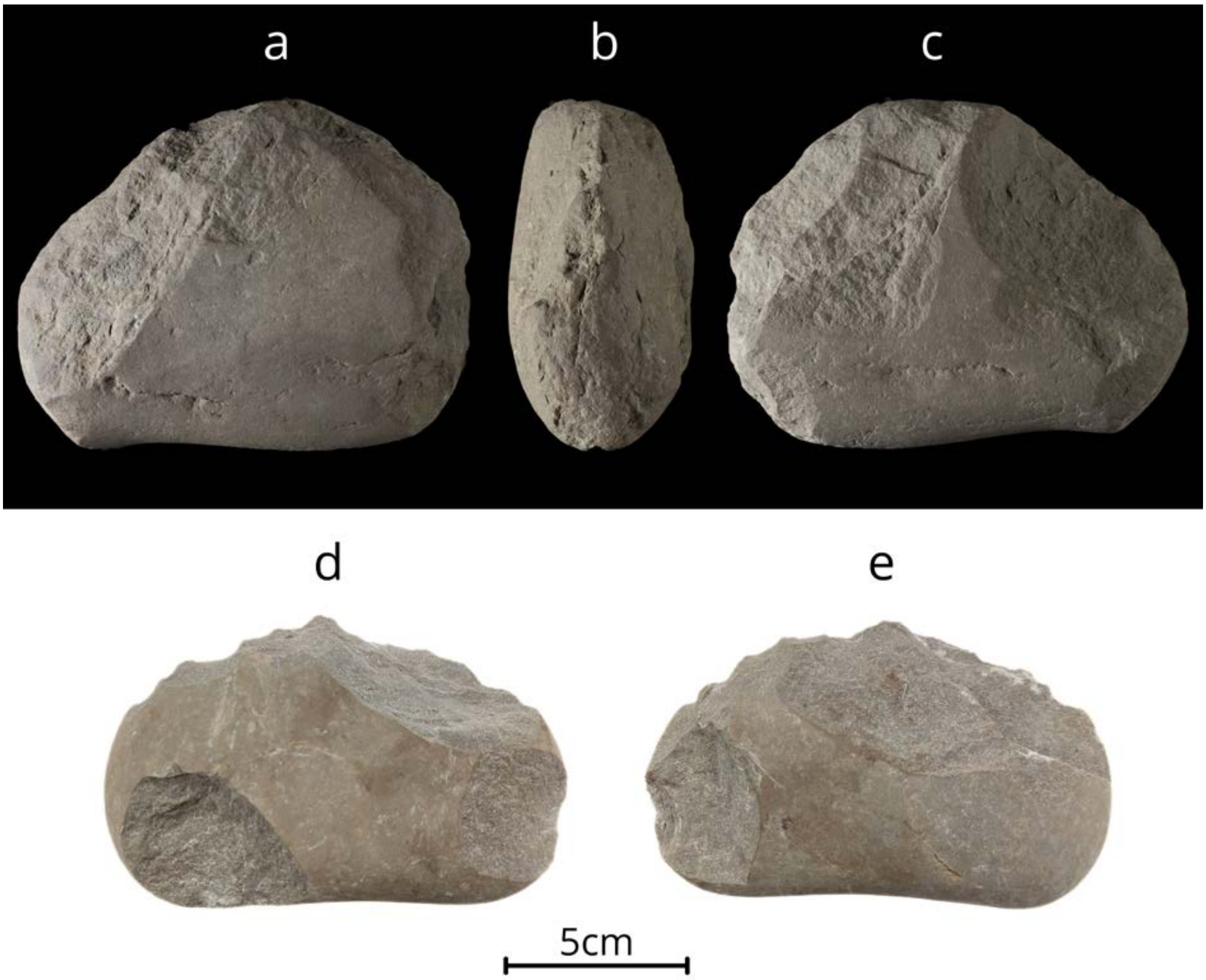

Figure 7. a-c) Flaked cobble from the Ness of Brodgar (photographs by Woody Musgrove). d-e) ‘Flaked cobble’ experiment G1, the top part of which was additionally retouched to provide a suitable working edge.

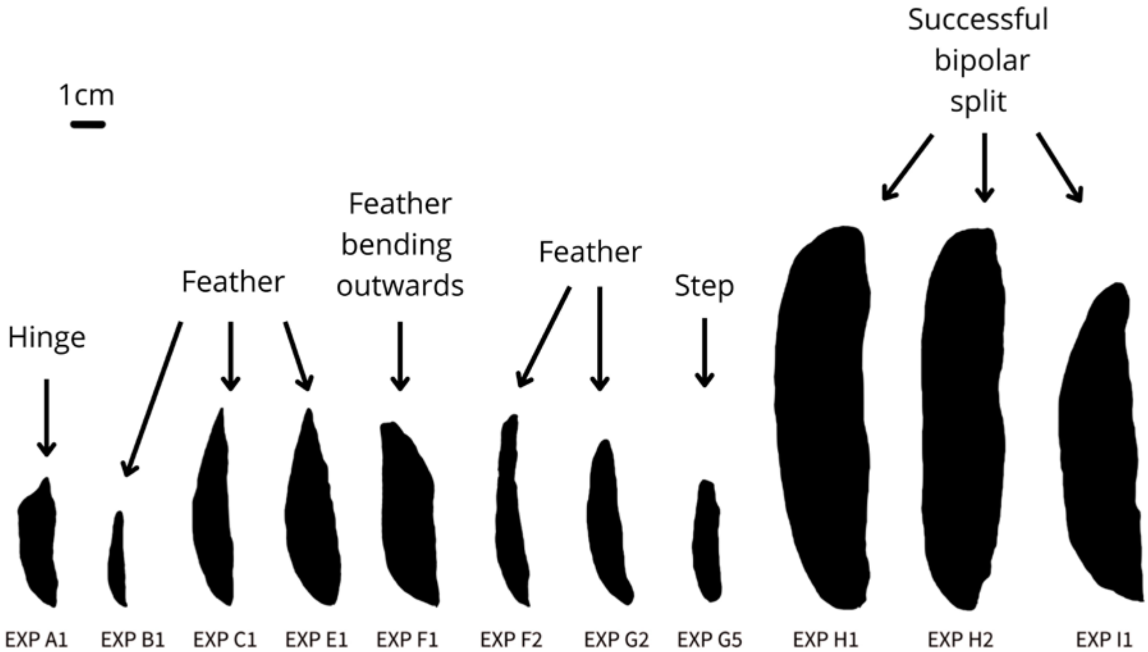

Figure 8. Terminations experimental Skaill knives, hinge, step, various types of feather terminations and bipolar splits. Cobbles which were used and Skaill knives which were retouched prior to use are excluded here.

Based on the profile of the Skaill knives it is possible to establish whether these represent flakes from a core, or split cobbles. Skaill knife production can take place following one of these *chaîne opératoires*, either splitting a cobble in half, ideally creating two large Skaill knives (as was the case with EXP H1 and H2, see Figure 9) creating no waste products. Alternatively, flakes are struck from a cobble creating one or several flakes, leaving a flake core as waste product (see Figure 9).

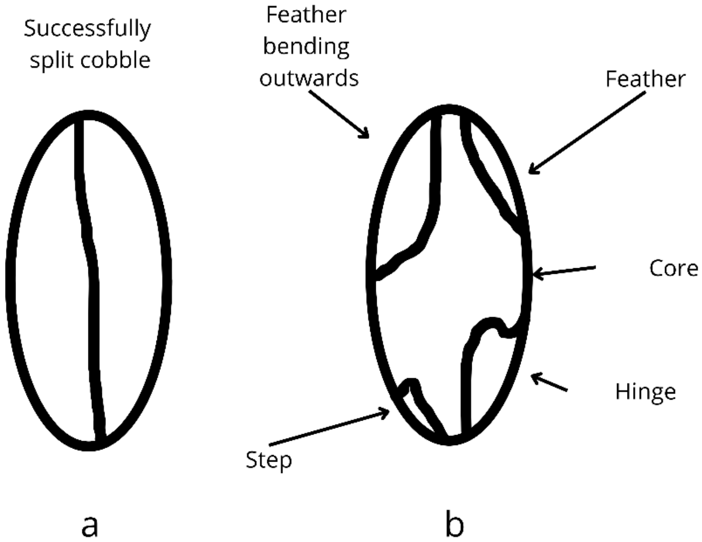

Figure 9. Schematic *chaîne opératoire*, a) Cobble is split in half creating two large Skaill knives with semi-oval profiles. b) Cobble from which several types of flakes are struck, leaving a flake core/flaked cobble as a waste product.

3.2. Archaeological Skaill knives descriptions and technological observations

The Skaill knives were measured and weighed prior to the analysis (see Table 2). Comparing the dimensions of the archaeological (Table 2) and experimental Skaill knives (Table 1) we can conclude that we were able to replicate Skaill knives of dimensions similar to those of the archaeological tools (e.g. EXP H1, H2, I1). However, due to the limited availability of suitable raw materials we also included some of the flakes with smaller dimensions in the experiments (e.g. EXP A1, B1, and G5). Technological features were also recorded, this included the presence of retouch and any indications for the use of bipolar technology. Steep retouch on one of the Skaill knives (NoB'08 2448) seemed to have been applied to assist grip during handling. In one instance (NoB'17 33632) it could not be established with any certainty if retouch was present. Weathered flake negatives on the dorsal side could have been intentionally made but they appear heavily weathered, suggesting they might have occurred naturally prior to production.

One of the Skaill knives appeared to be burnt (NoB'15, 23322) and another was possibly burnt (NoB'17, 33632). Both had a rough surface and seemed relatively light for their size. NoB'15, 23322 also displayed a clear reddish discoloration. Increased roughness and reddish discolorations are characteristic traits of burnt sandstone (Kompaníková *et al.* 2014). Heat exposure reduces the density of sandstone (Guo *et al.* 2023). Using 3D models the volume of the Skaill knives was calculated, which in turn was used to calculate the density of the Skaill knives (see Figure 10). This method showed that the two potentially burned Skaill knives had lower densities than the other unburnt examples.

Table 2. Metric data of archaeological Skaill knives.

Excavation	Context	Findnumber	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
NoB'08	TrP 1201	2448	11.3	8.3	2.3	159.1
NoB'08	TrP 1205	2500	14	10.7	2.9	423.9
NoB'15	TrT 4859	23322	10.3	7.1	1.8	120.5
NoB'15	TrT 4859	23351	7	7.7	1.7	104.4
NoB'15	TrP 1478	22787	7.8	10.7	2	201.4
NoB'16	TrP 7212	27654	6.1	7.3	2	98.6
NoB'17	TrP 7286	33632	13.6	7.3	2	145.2
NoB'18	TrT 4874	34941	5.6	7.1	1.1	51.7
NoB'18	TrJ 8151	34154	6.5	7	1.8	58.6
NoB'21	TrJ 9564	41576	6	8	1.5	57.8

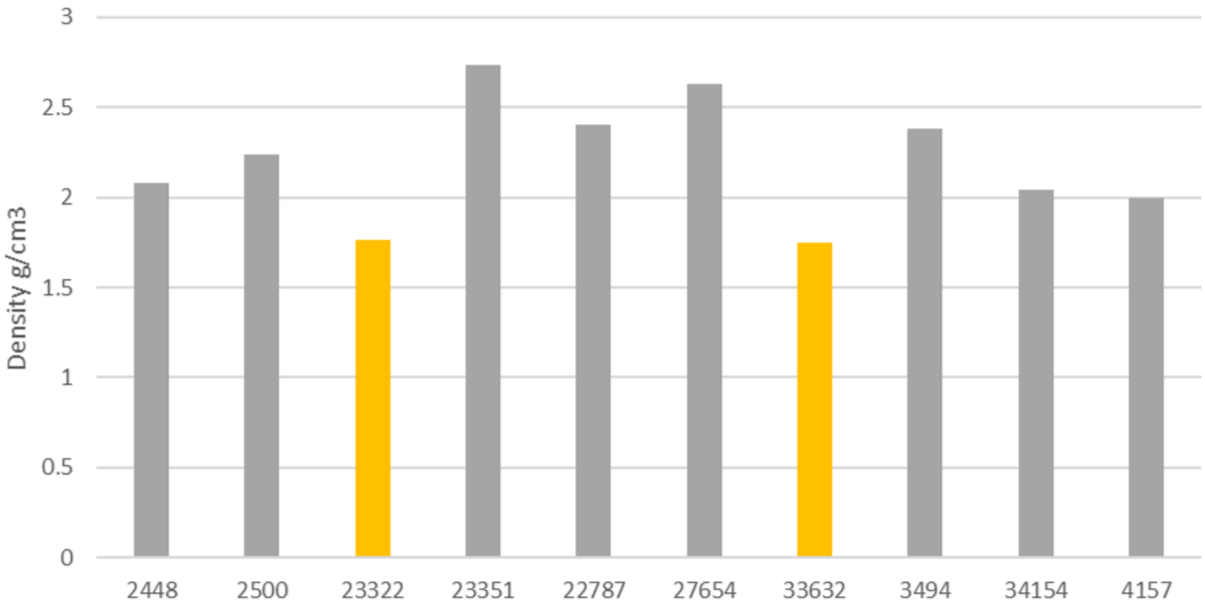

Figure 10. Density of the Skaill knives, in yellow are the two samples with signs of burning, which display a considerably lower density than the other, unburnt, Skaill knives.

3.2.1. Flake terminations

Our experiments indicated that large flakes could be detached in two ways: a cobble could be split in half creating two Skaill knives with a semi-oval profile, or flakes could be detached from a sandstone cobble (see section 3.1.1). By comparing experimentally produced and archaeological Skaill knives it could be established that both procedures were applied. Most Skaill knives represent flakes struck from a core (having hinge terminations and outwards bending feather terminations); in three instances the semi-oval profiles suggest that the cobbles were probably split in half (see Figure 11). The scarcity of sandstone flake cores/flaked cobbles as opposed to the abundance of Skaill knives at Ness of Brodgar further supports the hypothesis that Skaill knives were probably not produced at the site, at least, not in any significant numbers (Clarke 2020). However, more systematic studies are required to provide definitive answers.

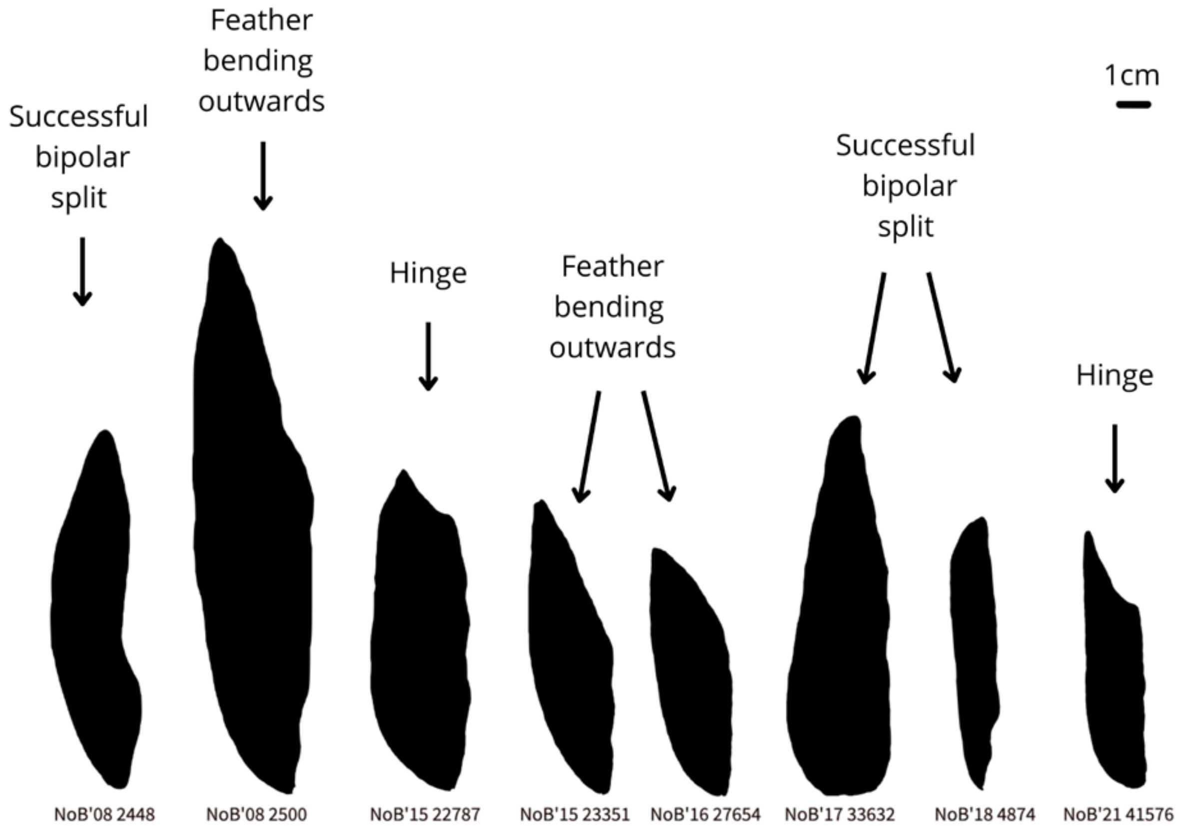

Figure 11. Archaeological Skaill knives side profiles with different terminations. Skaill knives with flake negatives on the dorsal face were excluded, as is the Skaill knife made from a broken cobble.

3.3. Experiments using Skaill knives

During the use-wear experiments it could be observed that the tools became inefficient after a several minutes of use. (See Table 3.) Often we continued to use the tools longer than what we deemed to be efficient (although modern conceptions of efficiency are not necessarily similar to those of the past). This loss of efficiency was noticed because the processes of scraping or cutting slowed remarkably after a while. It was clear that the edges were dulled by use at this stage. In earlier experiments Skaill knives were described as highly efficient butchering tools (Clarke 1989). This was generally not our experience. The edges became dull very quickly, which, especially for butchering and hide-working, rendered them inefficient after a short duration of use. In previous butchering experiments a selection of thirty tools were used over a period of two hours (Clarke 1989: 17). If used in such an expedient fashion heavy rounding is unlikely to occur. In Clarke's experiments only slight dulling and rounding of the edges were noted. Although it was noted that during disjointing, and other butchering activities which involved contact with bone, considerable edge damage occurred in the form of flaking. This apparently resharpened those tools, rendering them quite effective for this task (Clarke 1989). In our experiments we were perhaps too careful during disjointing, mostly cutting between the bones and only occasionally chopping.

Table 3. Results of use-wear experiments, detailing duration of use and description of the use-wear traces.

EXP	Motion	Contact material	Duration of use (min)	Description of use-wear traces
A1	Carving and cutting	Fresh red deer bone	81	Small edge removals and moderate edge rounding. Isolated spots of rough and matt polish with parallel striations on the rounded edge.
B1	Cutting and scraping	Meat off fresh red deer bone	53	Extensive small edge removals and slight edge rounding. Weakly developed generic polish with slight longitudinal directionality.
C1	Disjointing, cutting and chopping	Meat and fresh deer bone between astragalus, calcaneum and tibia	45	Extensive edge removals, mostly towards the dorsal side. Asymmetrical edge removals indicating longitudinal motion in parts. Macroscopic parallel striations.
E1	Disjointing, cutting and chopping	Meat and fresh deer bone between astragalus, calcaneum and tibia	66	Small edge removals and moderate edge rounding. Smooth and greasy polish on the rounded edge with longitudinal striations.
F1	Defleshing, cutting and scraping meat from hide	Fresh red deer hide	120	Slight edge rounding and small edge removals. No polish was identified on the tool.
F2	Cutting	Birch bark	20	Extensive small edge removals along the used edge. Slight rounding. No polish was identified on the tool.
G1	Carving and cutting	Sandstone with water	20	Small edge removals and heavy edge rounding (up to 5mm wide), combined with isolated spots, occasionally linked into a band, of smooth and matt flat polish. Polish has many fine striations parallel to the working edge.
G2	Scraping	Soft to leather hard clay	77	Slight edge rounding and isolated spots of bright rough and matt polish with perpendicular striations.
G5	Defleshing, cutting and scraping meat from hide	Fresh red deer hide	60	Slight edge rounding and small bifacial edge removals. Weakly developed rough and greasy polish on parts of the rounded edge.
H1	Defleshing, cutting and scraping meat from hide	Fresh red deer hide	240	Slight edge rounding and small edge removals. Slight rough and greasy polish band along the edge, some longitudinal directionality in the polish. Polish not well developed.
H2	Cutting and scraping	Meat off fresh red deer bone	93	Edge removals towards the dorsal face in parts, macroscopic edge rounding. Some weakly developed generic polish.
I1	Disjointing, cutting and chopping	Meat and fresh deer bone between astragalus, calcaneum, tibia and femur	68	Edge removals and moderate edge rounding. Very weakly developed rough and greasy polish along parts of the edge.
I2	Carving and cutting	Sandstone with water	22	Small edge removals and heavy edge rounding (up to 5mm wide), combined with isolated spots, occasionally linked into a band, of smooth and matt flat polish. Polish has many fine striations parallel to the working edge.

It was noted that macroscopic wear traces developed rapidly. On thinner edges, this resulted in a significant reduction of the working edges of the tools (see Figure 12). This rapid rate of reduction was also noted by Clarke during her butchering experiments (Clarke 1989: 24). It seems likely that this rapid development of macroscopic wear traces and subsequent reduction of the working edges hampers the development of polishes. Often the part of the edge where we would expect polish development was destroyed before polishes could develop. This issue is enhanced by the material properties of sandstone, because on sandstone tools polishes develop relatively slowly when compared, for example, to flint (Verbaas 2005).

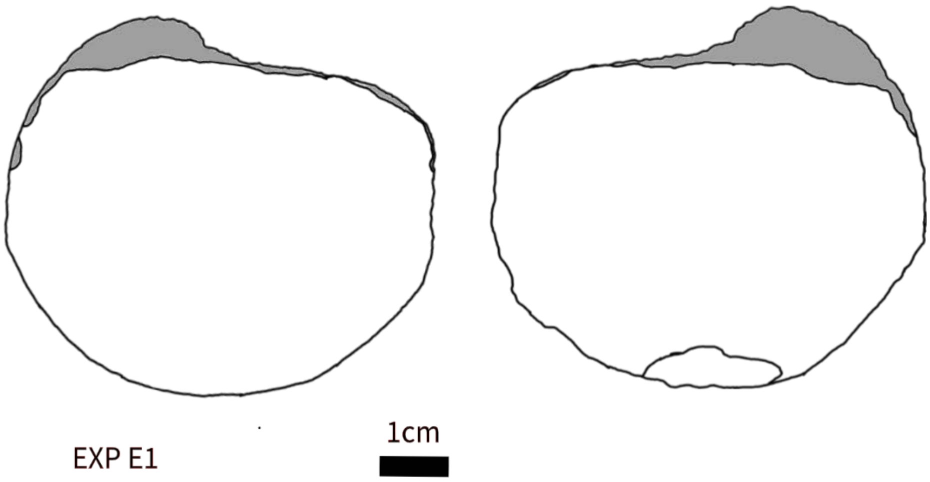

Figure 12. Edge reduction on experiment E1 (in grey) resulting from the use of the tool for disjointing for 66 minutes.

3.3.1. Butchering and hide-working

Butchering activities involving disjointing and scraping meat off bone resulted in the formation of edge removals, and slight edge rounding (Figure 13c and 13d). The rounding, and subsequent bluntness of the tools was highly noticeable during use. After a few minutes the tools no longer performed well in these tasks. We chose to keep using them, specifically with the aim of creating distinct wear traces. Macroscopically the wear traces matched those described in previous butchering experiments (Clarke 1989). In addition to edge removals, and rounding, one tool (EXP C1) displayed several macroscopic longitudinal striations, clearly indicating a cutting motion (see Figure 13d). The tools occasionally displayed weakly developed polishes directly on the working edge (see Figure 13a and 13b). The polishes were not distinctive; it is unlikely that these would be noticed on archaeological tools, especially if they also display post-depositional traces.

The red deer hide used in the hide-working experiments still had large chunks of meat on it which had to be cut away prior to scraping. This was unfortunate, as an expertly skinned hide likely would not have such chunks of meat, which would presumably have provided a more realistic scenario for the experiments. The hide-working tools were used for both activities, mostly for cutting meat from the hide (see Figure 14). As such, the experiments mostly represented defleshing activities (cutting between meat and hide, separating the two), rather than actual hide scraping experiments. Due to time constraints the experiments were limited to these activities. In future it would be worthwhile to further explore different hide-working stages, focussing explicitly on fresh and dry hide scraping.

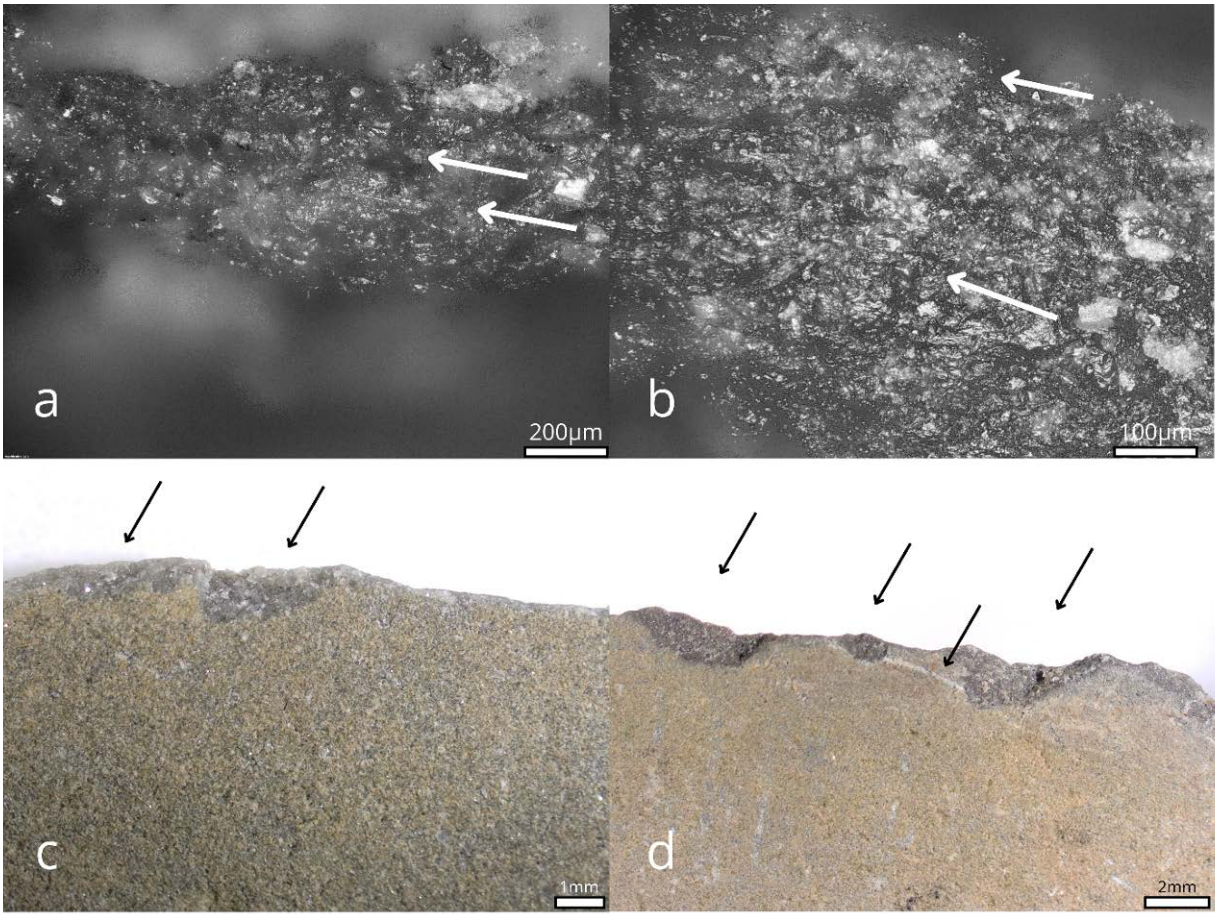

Figure 13. a) Experiment B1, weakly developed generic polish with slight longitudinal directionality (100x); b) Experiment E1, smooth and greasy polish on the rounded edge with longitudinal striations (200x); c) Experiment B1, small edge removals (10x); d) Experiment C1, small edge removals and macroscopic longitudinal striations (6.7x).

Figure 14. Hide-working experiment, cutting meat off red deer hide with Skaill knives YEAR Centre.

Even after three hours of tool use, the wear traces resulting from the hide-working experiments were weakly developed. Macroscopically, the traces were limited to a slight rounding of the edge with sparse edge removals. The polish was not well developed and could be characterised as a rough and greasy polish band along (parts of) the edge (see Figure 15a-b). The tool had become noticeably blunt after an hour. It seems unlikely that these tools would have been used for as long for such an activity. The other tools were used for a shorter duration of time. These displayed little or no polish. Experiment F1, which was used for two hours, did not display any polish. In sum, we suggest that it is unlikely that recognisable polishes would develop on NoB Skaill knives used for defleshing.

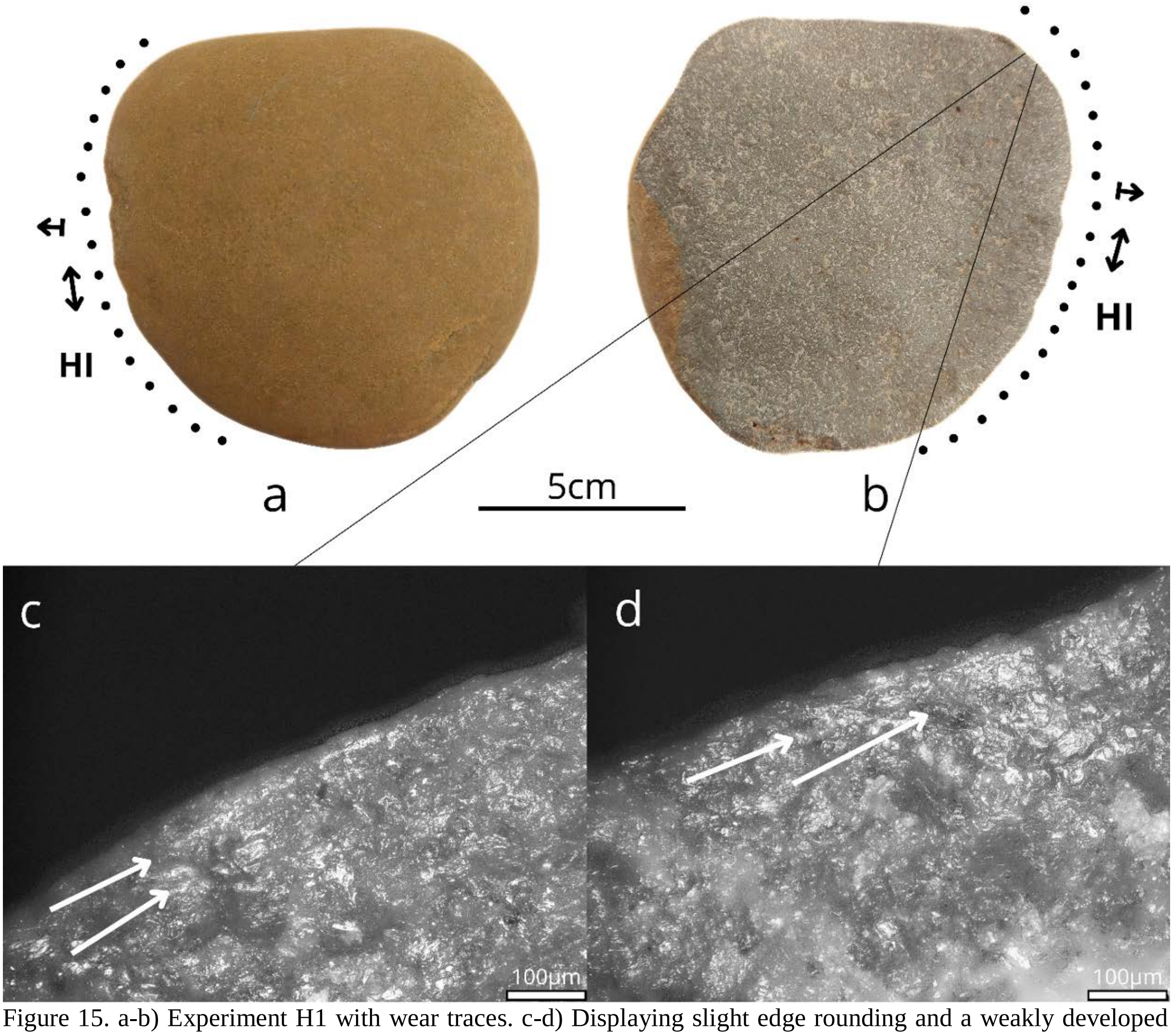

Figure 15. a-b) Experiment H1 with wear traces. c-d) Displaying slight edge rounding and a weakly developed greasy polish with longitudinal directionality.

3.3.2. Sandstone cutting, clay scraping, and cutting birch bark

Replica Skaill knives used for cutting through sandstone (with water) became extremely rounded after a short duration of use. In addition to rounding, edge removals occurred, although due to the thick edge of the tool these were relatively limited. The rounded parts displayed isolated spots of smooth and matt flat polish, which occasionally linked into a band of polish (see Figure 16). The polish is similar to the polish observed on flint tools used for cutting limestone, as described by Van Gijn (1990: 46; fig. 31C). To a lesser extent the polish, though not the distribution, also shows similarities to polishes resulting from grinding basalt on sandstone (Verbaas 2005: 55; fig. 26). We expect that traces relating to cutting or carving stone should be recognisable on archaeological Skaill knives. For flint it is known that different types of stone, for example limestone or jet, create different kinds of polishes (Van Gijn 1990: 46; Van Gijn *et al.* 2008: 222-223). Because our experiments only included sandstone it is not clear whether these traces are representative specifically for sandstone or whether other types of stone would leave similar traces.

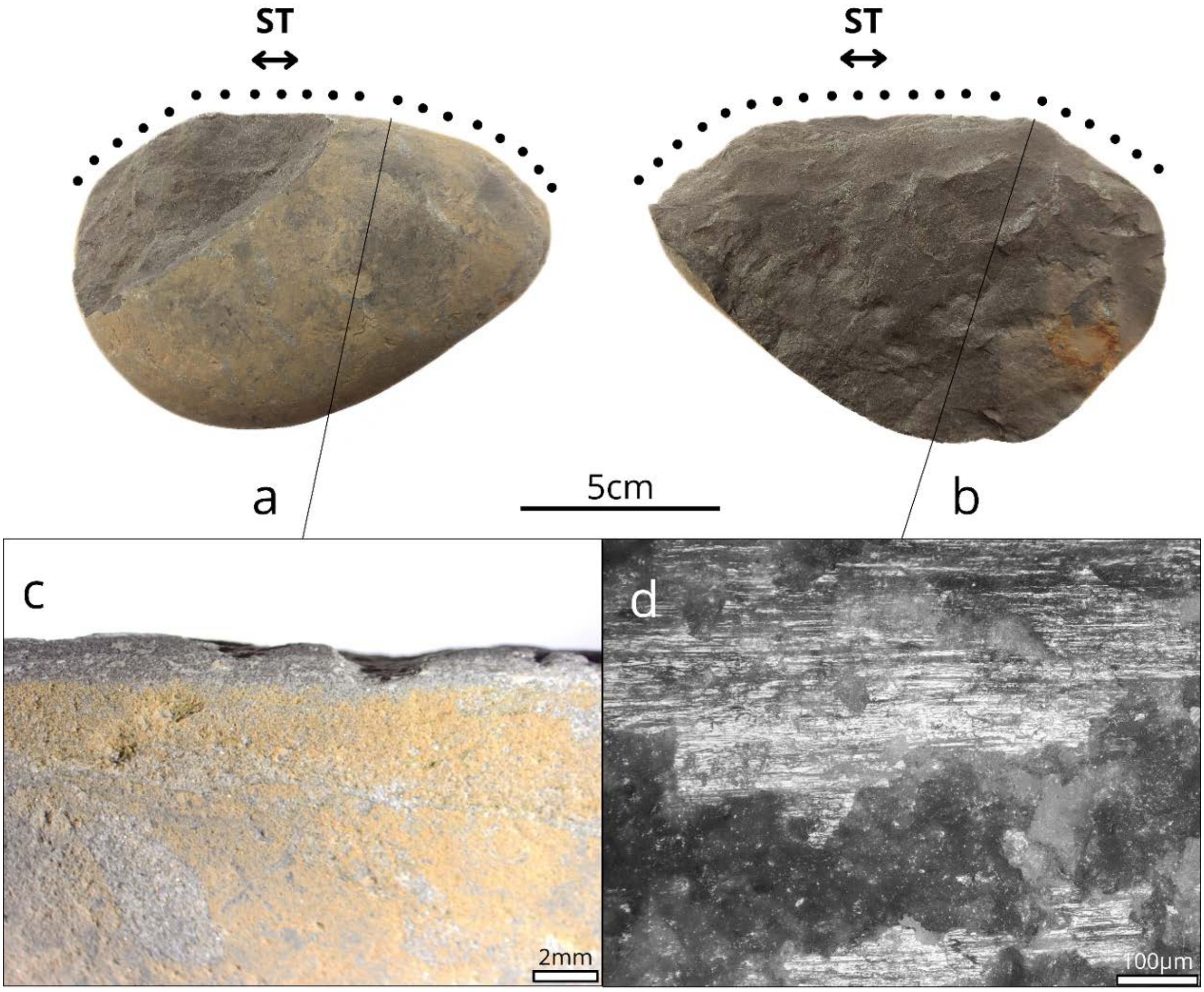

Figure 16. a-b) Experiment I2 carving and cutting sandstone. c) Stereomicroscopic photo of heavy rounding along the working edge (6.7x). d) Photograph with metallographic microscope of flat smooth and matt polish with parallel striations directly on the working edge (200x).

The scraping of clay resulted in a slightly rounded edge with, directly on the edge, a weakly developed rough and matt bright polish with a slight transverse directionality (Figure 17). It was noted that this tool remained very effective throughout the experiment. The rounding was remarkably homogenous and consistent.

The bark cutting experiment (see Figure 18) resulted in the formation of extensive small edge removals along the working edge of the tool. After twenty minutes of use the tool also become rounded and ineffective for the task at hand. No polishes were identified on the tool.

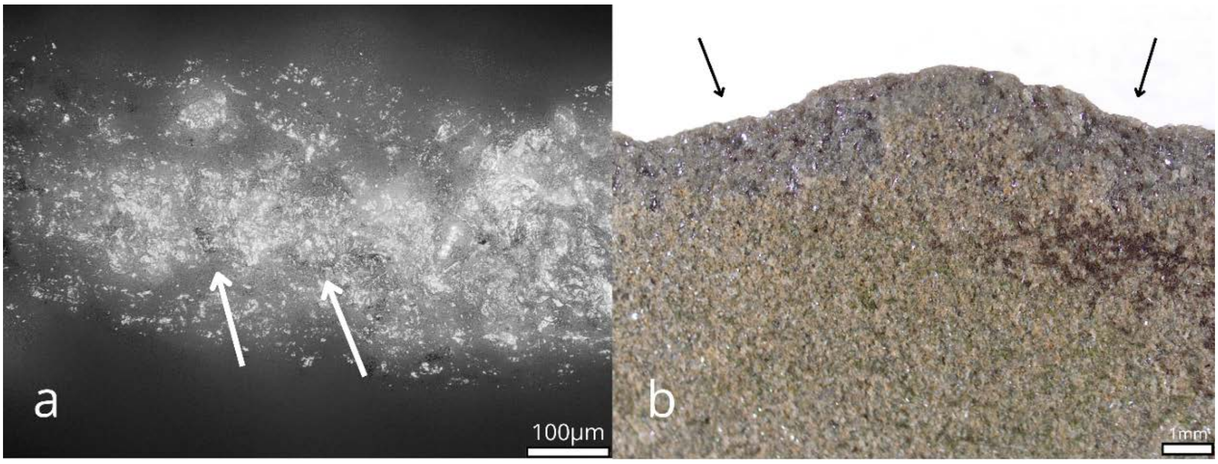

Figure 17. a) Microscope photo of polish observed on experiment G2 which was used to scrape soft clay (200x); b) edge removals on experiment F2 used to cut bark (10x).


Figure 18. Cutting birch bark with a Skaill knife (photo YEAR Centre).

3.4. Results use-wear analysis on archaeological Skaill knives

None of the archaeological Skaill knives displayed polishes. It is unclear to what extent this is due to preservation issues. Despite this lack of polishes, extensive macroscopic wear traces in the form of extensive edge rounding and edge removals could be observed (see Table 4 and Figure 18).

Table 4. Use-wear observed on archaeological Skaill knives.

Excavation	Find number	Rounding	Edge removals	Contact material	Motion
NoB'08	2448	Heavy	Extensive small	Unknown	Unknown
NoB'08	2448	Heavy	Extensive small	Unknown	Scraping
NoB'08	2500	Slight	Extensive small	Unknown	Unknown
NoB'15	22787	Heavy	Moderate	Unknown	Unknown
NoB'15	22787	Heavy	Moderate	Medium hard	Scraping
NoB'15	23322	Heavy	Few small	Medium hard	Scraping
NoB'15	23351	Absent	Possible edge removals	Possibly used	Possibly used
NoB'15	23351	Possible	Absent	Possibly used	Possibly used
NoB'16	27654	Slight	Absent	Unknown	Unknown
NoB'17	33632	Heavy	Extensive large	Unknown	Chopping?
NoB'17	33632	Heavy	Absent	Medium hard	Unknown
NoB'18	34154	Slight	Extensive small	Medium hard or hard contact material	Unknown
NoB'18	34941	Slight	Few small	Medium hard	Scraping
NoB'21	41576	Slight	Few small	Unknown	Unknown

In addition to rounding and edge removals, occasional distinctive V-shaped grooves were sometimes observed (see Figure 19f). It is unclear whether these are related to wear from use, or whether these should be interpreted as excavation damage. In one instance the extensive bifacial edge removals are thought to be related to a chopping motion (see Figure 19d). Due to the limited nature of the experimental program this could not be established with certainty.

On four Skaill knives, multiple zones of use were identified. NoB’08, 2448 displayed a clear rounded zone on the distal end of the dorsal face. The unifacial rounding, only on the dorsal side not on the ventral side, indicates that the tool was used in a scraping motion. On the side of the tool, extensive edge removals indicated a different type of use (see Figure 20). Those traces resembled both butchering traces as well as the traces from cutting bark in our experiments; however, our experiments did not yield traces which were comparable with the heavily rounded zones.

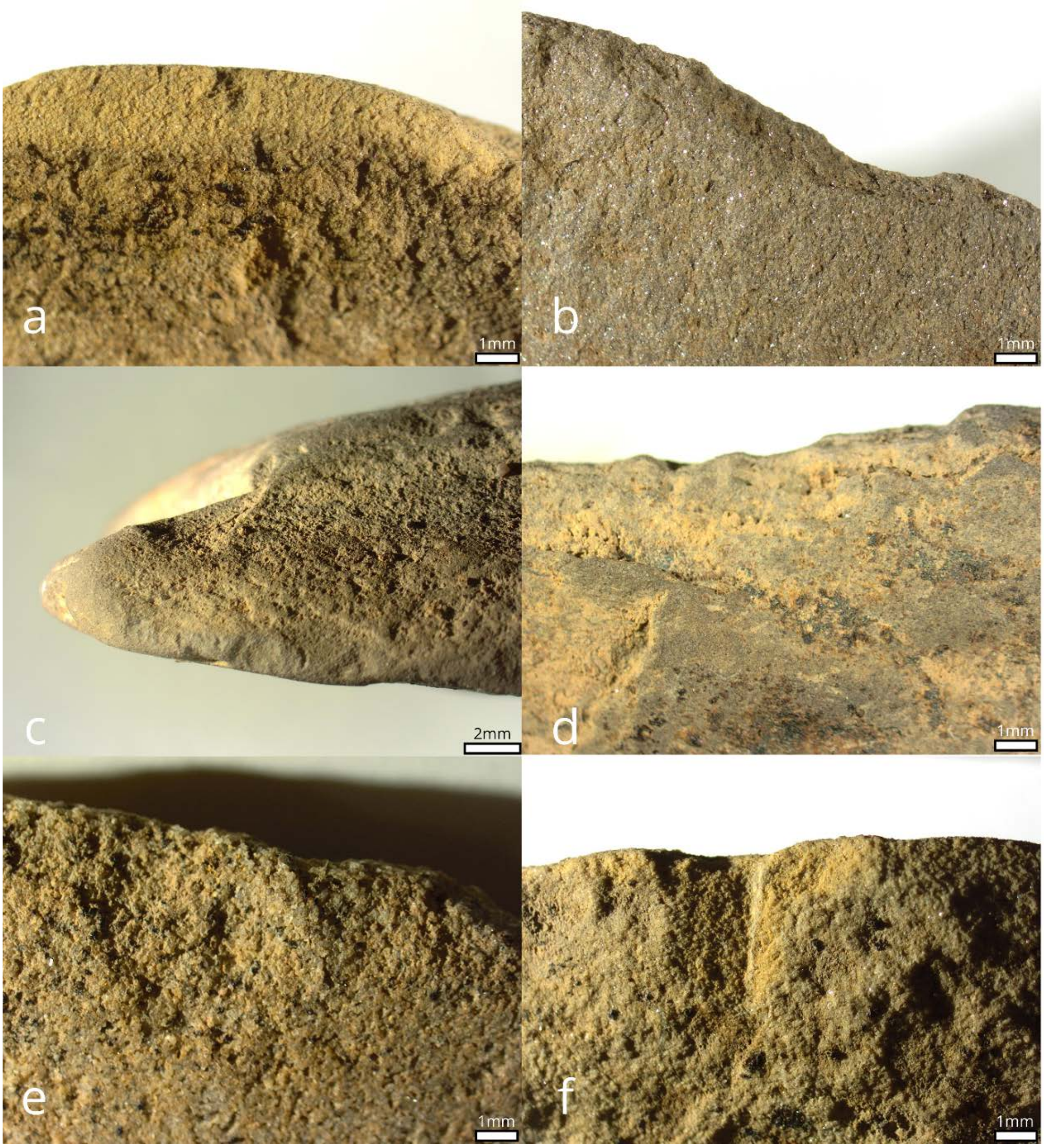

Figure 19. Wear traces on archaeological Skaill knives. a) NoB'15, 23322 heavy rounding on the ventral face of the tool. b) NoB'18, 34154 edge removals on the side of the tool. c) NoB'17 33632 heavy rounding on the pointed end of the tool. d) NoB'17 33632 extensive edge removals and slight rounding on the side of the tool. e) NoB'15 22787 edge removals and rounding. f) NoB'15, 23322 rounding and V-shaped groove.

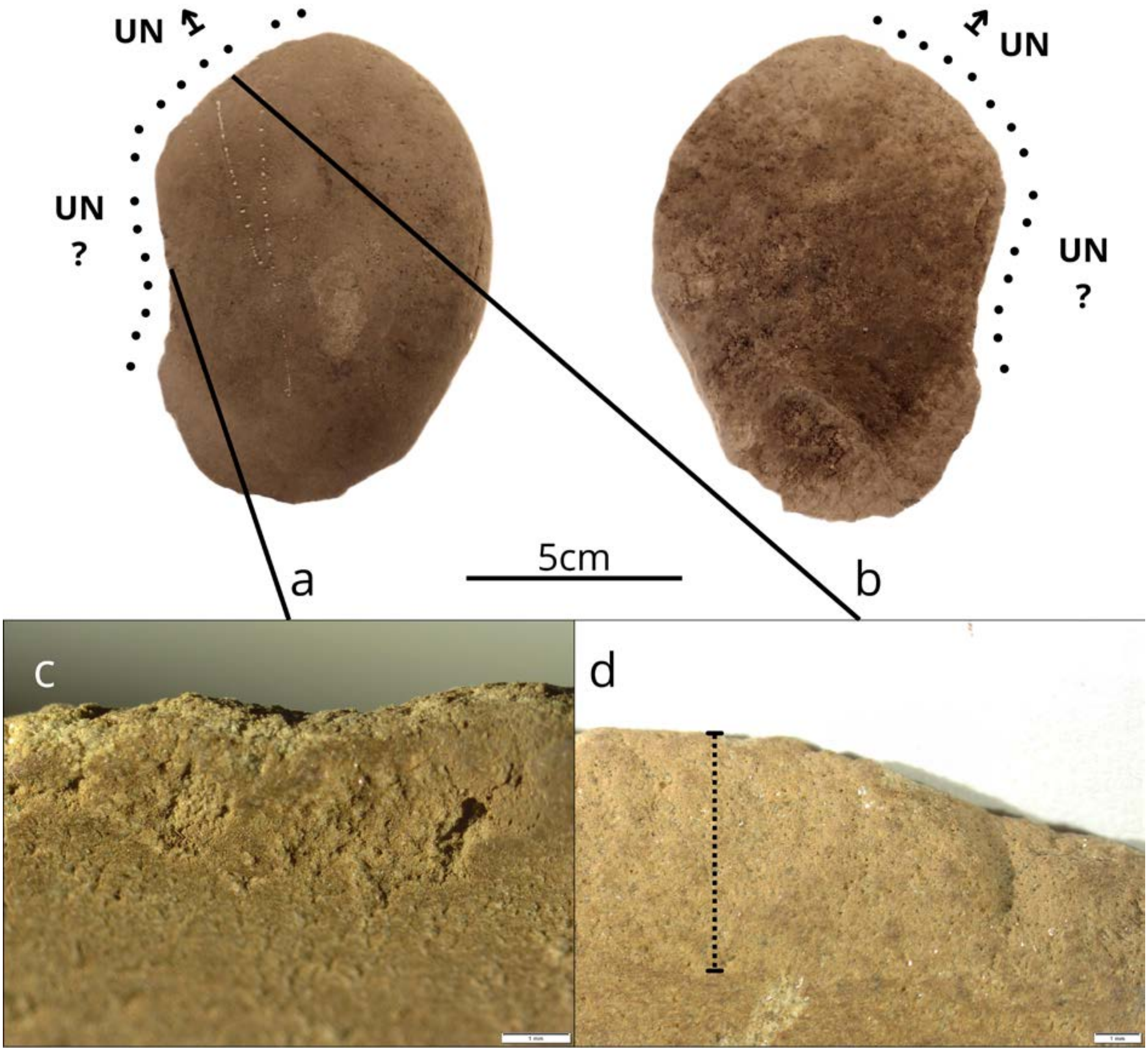

Figure 20.a-b) Skaill knife NoB'08, 2448, clearly displaying two types of wear traces. c) Worn zone with rounding and extensive edge removals. d) Heavily rounded zone with rounding towards the dorsal side (left: dotted line indicates the extent of the rounding), resulting from a scraping motion.

3.4.1. Scraping

Of the four Skaill knives made from splitting along the length of the cobble, three displayed clear traces resulting from a scraping motion (see Figure 21). Another tool which was split along the width of the cobble also displayed these traces on the convex distal short end of the tool (see Figure 21). Based on the location of these traces, it seems that these tools were specifically selected, and potentially specifically made, to be used as scraping tools. This further highlights the fact that the point of impact was deliberately chosen. Splitting along the length of the cobble is more difficult than splitting along the width, as the force needs to travel a greater distance within the stone. Yet, it seems that the end product, a Skaill knife with a sharp convex edge at the distal end, was the desired tool type. Skaill knife NoB'15 22787, which was split along the width instead of the length of the cobble, was a multifunctional tool. It could not be established which of the used zones was used first as there is no overlap between the used zones. It is possible that the tool was initially split along the width to use the long distal end of the flake, and that the scraping traces on the side resemble a secondary use. It would be worthwhile to further explore these observations through the study of a larger assemblage.

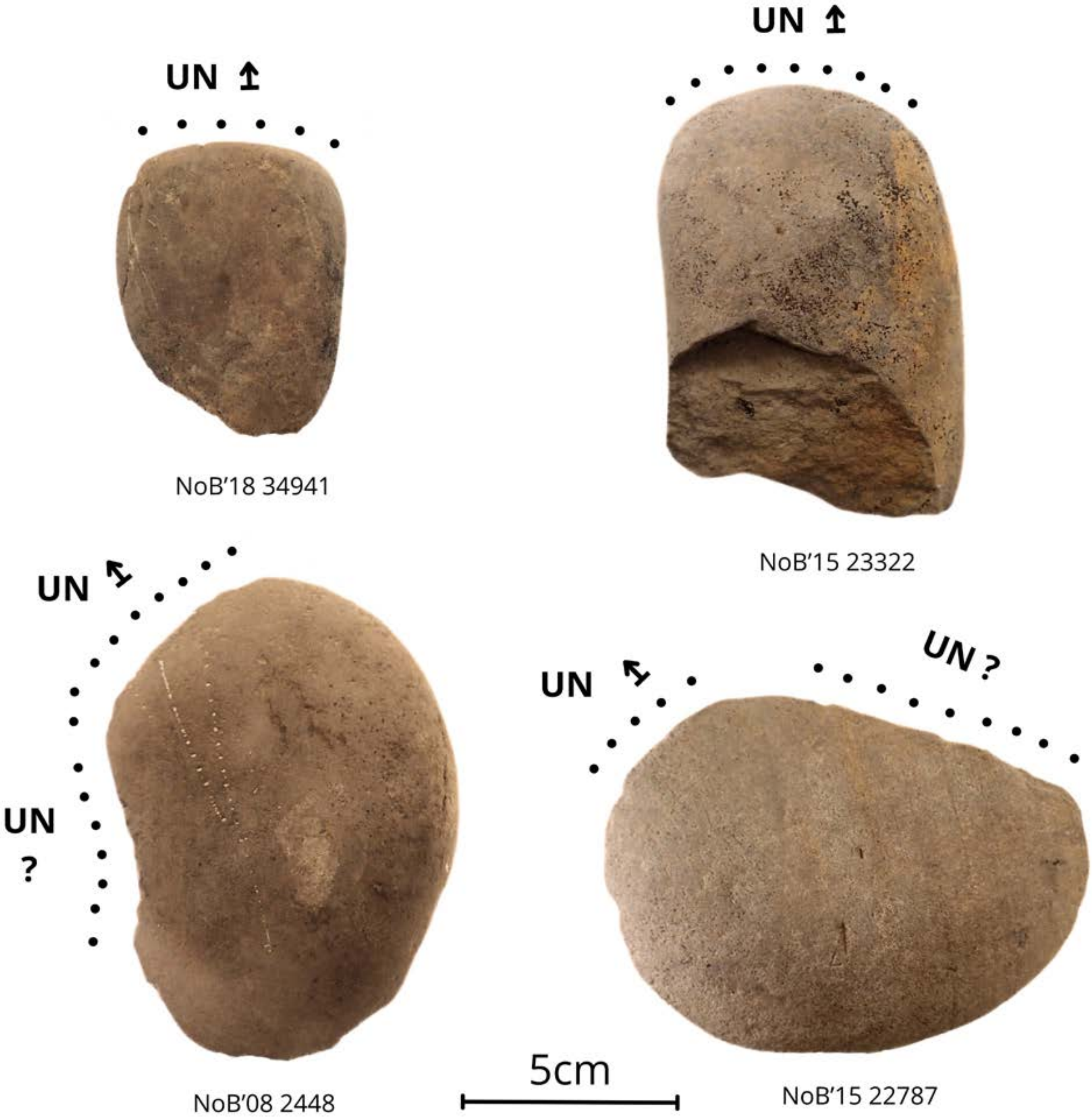

Figure 21. Archaeological Skaill knives used for scraping.

Morphologically these tools resemble *ad hoc* endscrapers. The distal curved dorsal face forms an ideal convex steep edge while the length of the tool provides a comfortable handle. In one instance the proximal end along the platform was retouched to provide a more comfortable grip (NoB'08 2448). The wear traces consist of a heavily rounded edge, occasionally combined with small edge removals. This kind of heavy rounding was not replicated in any of the experiments. It seems likely that this is either the result from contact with a very abrasive type of material or from a long duration of use, possibly a combination of both. In the experiments involving the scraping of meat from bone and fresh hide scraping the bluntness of the experimental tools rendered them ineffective for these tasks. It is unlikely that the archaeological examples would have been used extensively for these tasks as the rounding would have rendered them useless. Hide-working experiments involving the softening of dry hides were not part of the experimental program. This would be an interesting and viable option to test in the future, which might result in similar rounding, with dry hide scraping known to abrade tools rapidly (Van Gijn 1990: 28). It is also possible that these tools were used for thinning ceramic pots. Experimental scraping of clay (G2) yielded similar (though less well developed) traces of rounding along the convex edge. In this case the rounding did not affect the efficiency of the tool as it had in the other activities described above. This might explain the heavy rounding on the archaeological tools – something to be explored in further experimental work, also involving tempered leather-hard clay.

4. Discussion

This study has provided valuable new insights into the *chaîne opératoire* of a sample of the Skaill knives recovered from the Ness of Brodgar. Controlled bipolar flaking appears the most plausible production method. The technological observations based on our experiments might help to interpret other coarse stone tool assemblages. It was observed that the decorated Skaill knife from Skara Brae, published by Saville, has a feather termination which bends outwards (Saville 1994: 105): indicating that the force was insufficient to split the cobble in half, after which a large flake detached from a cobble core.

Morphologically it seems that there are two distinct types of functional edges: 1. convex steep edges on the distal ends of cobbles which are split along their length; 2. Wide cutting edges along the distal end of cobbles which are split along the width of the cobble (see Figure 22). The first type of edge is generally associated with traces from scraping. The other type of edge usually has extensive small edge removals. These could be related to butchering activities, though this cannot yet be demonstrated for certain. In one example, the nature of the edge removals seems to suggest that the tool was possibly used in a chopping motion. This would fit well with the hypothesis that these tools were used for butchering, corroborating the earlier observations by Clarke (1989). Nevertheless, it should be noted that the butchery experiments indicated that these tools were not very well suited for this task. Therefore, it is advisable that future studies also incorporate more alternative uses. Regarding the scraping traces (the unifacial heavy edge rounding), this is the first study to note the systematic occurrence of such traces on archaeological Skaill knives. While we were unable to successfully link them to a specific activity this is a category of traces which should in the future be explored more in-depth.

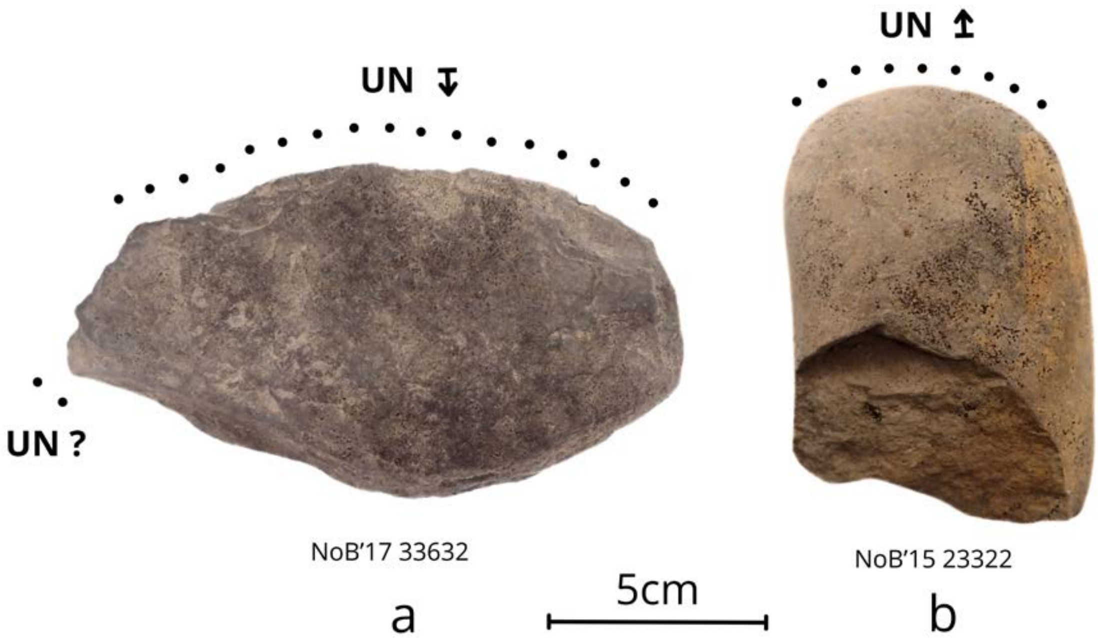

Figure 22 . Two types of Skaill knives. a) Tool split along the width of the cobble with an edge possibly used for chopping (perhaps related to butchering). b) Tool split along the length of the cobble used for scraping an abrasive material.

5. Conclusion

This pilot study provides insights into the potentials of a detailed study of Skaill knives. We conclude that a detailed study of the technology to produce these tools is worthwhile and is something that should be done on a larger scale, perhaps comparing the relationship between Skaill knives and other stone tool categories, such as flaked cobbles. It is further recommended that such a study extends beyond the Ness of Brodgar to also include other sites in Orkney.

Due to the rapid development of macroscopic wear traces, the potential for studying microscopic use-wear is limited. This might further be hampered due to preservation issues. Even with a more extensive experimental program, it would be difficult to link wear traces to specific contact materials. Nevertheless, the macroscopic wear on archaeological Skaill knives indicates that they are relatively a diverse category. Preliminary observations suggest that there is a difference between scraping tools, made from cobbles which are split along the length to provide a steep convex scraping edge, and other tools which are potentially used for butchering. Tools which are split along the width of the cobble provide a long sharp cutting edge on the distal end of the tool. Wear traces on these tools consist of extensive small edge removals combined with edge rounding. We propose that these tools could be butchering tools as previously suggested, but without archaeological polishes this still remains a tentative hypothesis (Clarke 1989; 2006; Richards *et al.* 2015). We further suggest a more in-depth exploration of the variation in macroscopic traces in relation to the choices made during the production phase. While we have observed some patterns, with the small sample presented here, the relationship between lengthwise split cobbles and scraping traces remains hypothetical.

To conclude, Skaill knife *chaîne opératoires* were more complex and deliberate than previously assumed. Although we were not able to assign specific contact materials to the observed use-wear traces we were able to demonstrate that Skaill knives were employed in different tasks. It is recommended that technological features such as termination types and possible bipolar scars are systematically recorded to build a greater understanding of Skaill knife technologies. Even though microscopic use-wear analysis yielded limited results, our study demonstrates the value of documenting macroscopic features such as rounding and edge removals in a systematic way.

Acknowledgements

We thank Gareth Perry for helping us with initial tests using the SEM-EDX, something we later abandoned in the project. We would like to thank Mik Lisowski and Becky Knight for their help with setting up the experiments and providing access to materials. This research was funded by the NWO project: *Putting life into Late Neolithic houses: investigating domestic craft and subsistence activities through experiments and material analysis* (AIB.19.020). We would like to thank Annelou van Gijn, PI of the Putting Life into Late Neolithic houses project for encouraging the fruitful research stay of LvdD in York. We would like to thank Ann Clarke for providing valuable comments on an earlier version of the article. Finally, we would like to thank the anonymous reviewers for their helpful comments and suggestions.

Data accessibility statement

The data is made available in the text and tables contained in the article as well as in the csv. uploaded as supplementary material. The 3D models are made available as supplementary files through the Zenodo repository (DOI: https://doi.org/10.5281/zenodo.14290154).

List of supplementary files

Supplementary file 1
"Van_den_Dikkenberg_et_al. - supplementary file 1 - 3D-models"
Folder uploaded in Zenodo with all 3D-models of the ten archaeological Skaill knives, uploaded as ply., obj., and stl. files, including associated jpeg. files for colour maps. DOI: https://doi.org/10.5281/zenodo.14290154

References

Artec 3D. (2015), *Artec Space Spider. Blue-light surface scanner*, Artec 3D, Luxembourg. URL: https://www.artec3d.com/

Artec 3D. (2020), *Artec Studio 15. Software,* Artec 3D, Luxembourg. URL: https://www.artec3d.com/

Card, N., Edmonds, M. & Mitchell, A. (Eds.) 2020, *The Ness of Brodgar: As it stands*, The Orcadian, Kirkwall, 388 p.

Childe, V.G., Paterson, J.W. & Bryce, T.H. 1929, Provisional Report on the Excavations at Skara Brae, and on Finds from the 1927 and 1928 Campaigns. *Proceedings of the Society of Antiquaries of Scotland*, 63: 225-280. DOI: https://doi.org/10.9750/PSAS.063.225.280

Clarke, A. 1989, The Skaill knife as a butchery tool. *Lithics*, 10: 16-27.

Clarke, P.A., 1995. *Observations of Social change in Prehistoric Orkney and Shetland Based on a Study of the Types and Context of Coarse Stone Artefacts.* Unpublished M.Litt. thesis at the Department of Archaeology, University of Glasgow, Glasgow, 597 p.

Clarke, A. 2006, *Stone tools and the prehistory of the Northern Isles / Ann Clarke*. British Archaeological Reports Ltd, Oxford, 141 p.

Clarke, A. 2020, Stone Tools from Ness of Brodgar. Chapter 18. In: *The Ness of Brodgar: As it stands* (Card, N., Edmonds, M. & Mitchell, A., Eds.), The Orcadian, Kirkwall: p. 224-243.

Dubreuil, L. & Savage, D. 2014, Ground stones: a synthesis of the use-wear approach. *Journal of Archaeological Science*, 48(0): 139-153. DOI: https://doi.org/10.1016/j.jas.2013.06.023

Farrell, M., Bunting, M.J., Lee, D.H.J. & Thomas, A. 2014, Neolithic settlement at the woodland's edge: palynological data and timber architecture in Orkney, Scotland. *Journal of Archaeological Science*, 51: 225-236. DOI: https://doi.org/10.1016/j.jas.2012.05.042

Van Gijn, A.L. 1990, *The wear and tear of flint. Principles of functional analysis applied to Dutch Neolithic assemblages*. Analecta Praehistorica Leidensia Vol. 22. Faculty of Archaeology, Leiden, 183 p.

Van Gijn, A.L. 2008. Toolkits and technological choices at the Middle-Neolithic site of Schipluiden, The Netherlands. In: *“Prehistoric Technology” 40 years later: Functional studies and the Russian legacy. Proceedings of the International Congress Verona (Italy), 20-23 April 2005* (L. Longo, N. Skakun, Eds.), BAR Series Vol. 1783, Archeopress, Oxford: p. 217-225.

Guo, J., Lei, Y., Yang, Y., Cheng, P., Wang, Z. & Wu, S. 2023, Effects of High Temperature Treatments on Strength and Failure Behavior of Sandstone under Dynamic Impact Loads. *Sustainability*, 15(1): 794. URL: https://www.mdpi.com/2071-1050/15/1/794

Hamon, C. & Plisson, H. 2008, Functional analysis of grinding stones: the blind-test contribution. In: *Prehistoric Technology' 40 years later: Functional Studies and the Russian Legacy. Proceedings of the International Congress Verona (Italy), 20-23 April 2005* (Longo, L. & Skakun , N., Eds.), BAR International Series, Archaeopress, Oxford: p. 29-38.

Hamon, C. 2016. Technology and function of grooved abraders in the early Neolithic of northwestern Europe. *Journal of Lithic Studies*, 3(3): 243-259. DOI: https://doi.org/10.2218/jls.v3i3.1649

Hayes, E., Pardoe, C., & Fullagar, R. 2018. Sandstone grinding/pounding tools: Use-trace reference libraries and Australian archaeological applications. *Journal of Archaeological Science: Reports*, 20: 97-114. DOI: https://doi.org/10.1016/j.jasrep.2018.04.021

Hurcombe, L. 2008, Organics from inorganics: using experimental archaeology as a research tool for studying perishable material culture. *World Archaeology*, 40(1): 83-115. DOI: https://doi.org/10.1080/00438240801889423

Jones, A., 2001. A biography of ceramics in Neolithic Orkney. In: *Archaeological Theory and Scientific Practice* (Jones, A., Ed.). Topics in Contemporary Archaeology. Cambridge University Press, Cambridge: 145-167.

Kompaníková, Z., Gomez-Heras, M., Michňová, J., Durmeková, T. & Vlčko, J. 2014, Sandstone alterations triggered by fire-related temperatures. *Environmental Earth Sciences*, 72(7): 2569-2581. DOI: https://doi.org/10.1007/s12665-014-3164-2

Kutschera, W. & Rom, W. 2000, Ötzi, the prehistoric Iceman. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, 164-165: 12-22. DOI: https://doi.org/10.1016/S0168-583X(99)01196-9

Lloyd, G. 2024, *Coarse Stone Tools from the Ness of Brodgar: Investigating the Function and Significance of Orcadian Neolithic Multi-Hollowed Cobbles.* Unpublished Master of Research Thesis, UHI Orkney, Archaeology Institute, Kirkwall, 220 p.

Mainland, I., Blanz, M., Ayres, J. & Webster, C. 2020, Cattle and other animals: human-animal relationships at the Ness of Brodgar. Chapter 21. In: *The Ness of Brodgar: As it stands* (Card, N., Edmonds, M. & Mitchell, A., Eds.), The Orcadian, Kirkwall: p. 266-277.

Pelegrin, J. 1990. Prehistoric lithic technology: Some aspects of research. *Archaeological Review from Cambridge*, 9(1): 116-125. DOI: https://doi.org/10.17863/CAM.109791

Petrie, G. 1870, Notice of Ruins of Ancient Dwellings at Skara, Bay of Skaill, in the Parish of Sandwich, Orkney, recently excavated. *Proceedings of the Society of Antiquaries of Scotland*, 7(1): 201.

Van Regteren Altena, J.F., Bakker, J.A., Clason, A.T., Glasbergen, W., Groenman-van Waateringe, W. & Pons, L.J. 1962, The Vlaardingen culture I. *Helinium*, 2: 3-35.

Richards, C., Clarke, A., Ingrem, A. & Mulville, C.M., I. 2015, Containment, closure and red deer: a Late Neolithic butchery site at Skaill Bay, Mainland, Orkney. *Proceedings of the Society of Antiquaries of Scotland*, 145: 91-124. DOI: https://doi.org/10.5284/1000184

Saville, A. 1994, A decorated skaill knife from Skara Brae, Orkney. *Proceedings of the Society of Antiquaries of Scotland,* 124: 103-111.

Sellet, F. 1993. Chaine Operatoire; The concept and its applications. *Lithic Technology*, 18(1-2): 106-112. DOI: https://doi.org/10.1179/009346990791548349

Verbaas, A. 2005, *Stenen werktuigen en hun gebruik; een onderzoek naar de stenen werktuigen van Geleen-Janskamperveld en de gebruikssporenanalyse op stenen werktuigen als methode*. Unpublished MA thesis thesis at the Faculty of Archaeology, Leiden University, Leiden, 92 p. (in Dutch)("Stone tools and their use; a study on the stone tools of Geleen-Janskamperveld and the use-wear analysis on stone tools as method")

Verbaas, A. & Van Gijn, A.L. 2007, Querns and other hard stone tools from Geleen-Janskamperveld. Chapter 13. In: *Excavations at Geleen-Janskamperveld 1990-1991* Vol. 39 (Van de Velde, P., Ed.), Analecta Praehistorica Leidensia, Faculty of Archaeology, Leiden: p. 191-204.

Wentink, K., Van Gijn, A.L. & Joosten, I. 2024, Shine on you crazy diamond: Functional analysis of the stone and flint tools from the Ommerschans hoard. In: *Larger than Life. The Ommerschans hoard and the role of giant swords in the European Bronze Age (1500-1100 BC)* Vol. 30 (Amkreutz, L.W.S.W. & Fontijn, D.R., Eds.), PALMA: Papers on Archaeology of the Leiden Museum of Antiquities, Sidestone Press, Leiden: p. 181-194.

Zupancich, A., Cristiani, E., Carra, M., Antonović, D., & Borić, D. 2025. Mesolithic plant processing unveiled: Multiscale use-wear analysis of the ground stone tools from Vlasac (Serbia). *Journal of Archaeological Science: Reports*, 61, 104907. DOI: https://doi.org/10.1016/j.jasrep.2024.104907

‘Skaill knives’ van de Ness of Brodgar: een experimentele studie om het potentieel voor gebruikssporenanalyses en technologische analyses in kaart te brengen

Lasse van den Dikkenberg [1], Jacob Lyons [2], Tom Foley [2], Laura Fitton [3], Nick Card [4], Mark Edmonds [3], Aimée Little [2]

1. Universiteit Leiden, Faculteit der Archeologie, Departement voor Archeologische Wetenschappen, Materiele Cultuur Studies. Van Steenis gebouw, Einsteinweg 2, Leiden 2333CC, Nederland. Email: l.van.den.dikkenberg@arch.leidenuniv.nl
2. Centrum voor Artefacten Materialen en het YEAR Centrum, Departement voor Archeologie, Universiteit van York, Heslington, York YO10 5DD, Verenigd Koninkrijk. Email: Lyons: lyonsj19@gmail.com; Foley: tomfoley2001@gmail.com; Little: aimee.little@york.ac.uk
3. Universiteit van York, Departement voor Archeologie, Hull York Medische School, Wentworth Way, Heslington, York YO10 5DD, Verenigd Koninkrijk. Email: Fitton: laura.fitton@hyms.ac.uk; Edmonds: edmonds@york.ac.uk
4. Universiteit van de Hooglanden en Eilanden, Archeologie Instituut, UHI Orkney, Kirkwall, Orkney KW 15 1LX, Verenigd Koninkrijk. Email: nick.card@uhi.ac.uk

Samenvatting:

Dit artikel presenteert de resultaten van ons onderzoek naar de biografieën van ‘Skaill knives’ van de Neolithische opgraving ‘Ness of Brodgar’ (VK). Skaill knives zijn grote zandstenen afslagen die zijn gemaakt van gerolde stenen, afkomstig van de stranden van Orkney. We presenteren een experimentele studie waarbij we deze messen hebben nagemaakt en gebruikt. Naast deze experimentele werktuigen hebben we een selectie van tien archeologische ‘Skaill knives’ onderzocht door middel van gedetailleerde technologische en functionele analyses. Het gebruikssporenonderzoek is uitgevoerd met zowel stereomicroscopie (met lage vergrotingen 2-50x) als ook door middel van metallografische microscopie (hoge vergrotingen 50-500x). Van alle archeologische werktuigen zijn ook 3D-modellen gemaakt om de technologische kenmerken en gebruikssporen beter te visualiseren en te onderzoeken. Het onderzoek naar de productie van ‘Skaill knives’ toonde aan dat het waarschijnlijk is dat deze werden gemaakt door middel van bipolaire percussie. Eerder werd aangenomen dat deze messen werden gemaakt door een steen tegen andere stenen aan te gooien. Hierbij zouden dan afslagen afspringen die als messen gebruikt kunnen worden. Hoewel deze techniek mogelijk ook werkt, lijken de technologische kenmerken op de archeologische messen erop te wijzen dat deze op een systematische wijze zijn gemaakt. Hierbij lijkt het punt van impact duidelijk bewust gekozen te zijn, daarom lijkt het ons onwaarschijnlijk dat deze messen zijn gemaakt door het gooien van de stenen tegen andere stenen. De analyse van de distale uiteinden van de archeologische werktuigen, in vergelijking met de experimentele werktuigen, toonde aan dat deze op verschillende wijzen zijn ontstaan. Sommige messen zijn ontstaan doordat de stenen succesvol in tweeën zijn gesplitst. Bij veel van de werktuigen lijkt de klap echter niet hard genoeg te zijn geweest om de steen in tweeën te splijten. Hierbij zijn aan het distale einde zogenaamde ‘hinges’ ontstaan. Het andere deel van de steen vertoont dan een duidelijk afslag negatief, zoals deze ook gezien kunnen worden op de ‘flaked cobbles’ die bij deze opgraving gevonden zijn. Door dit onderzoek konden we dus de productiesequenties voor het maken van ‘Skaill knives’ koppelen aan de productiesequenties voor het maken van deze ‘flaked cobbles’. De experimentele werktuigen vertoonden na gebruik niet of nauwelijks gebruikssglans. Macroscopische gebruikssporen zoals afronding en afsplinteringen konden echter wel regelmatig worden waargenomen. Bij de archeologische werktuigen werden verschillende typen gebruikssporen waargenomen. Sommige zones vertoonden sterke unifaciale afronding, dit kan waarschijnlijk gekoppeld worden aan een schrapende beweging waarbij een abrasief materiaal is geschraapt. Andere gebruiksszones vertoonden vooral afsplinteringen. Deze sporen kunnen mogelijk gekoppeld worden aan slachten, zoals eerder was voorgesteld. Het is echter ook mogelijk dat deze sporen resulteren door contact met een harder materiaal. Morfologisch komen deze sporen voor op verschillende zones op de ‘Skaill knives’. De sterke afronding komt vaak voor op de korte zijde van messen die gemaakt zijn door een steen in de lengterichting te splijten. De afsplinteringen komen vaker voor op de lange zijdes van stenen die in de breedte zijn gespleten. Omdat de archeologische werktuigen geen gebruiksglans vertoonden kon bij beide sporen geen specifiek contactmateriaal herleid worden. Wel toonde dit onderzoek aan dat ‘Skaill knives’ multifunctionele werktuigen zijn en dat ze wat betreft gebruik mogelijk twee verschillende typen werktuigen vertegenwoordigen. Een deel lijkt gebruikt te zijn om te schrapen, andere werktuigen werden gebruikt voor de slacht of voor het bewerken van hard materiaal. Het onderzoek bood dus interessante nieuwe inzichten in de productie en het gebruik van deze zandstenen messen.

Trefwoorden: ‘Skail knives’; Neolithicum; Orkney; gebruikssporenanalyse; experimentele archeologie; steen; zandstenen werktuigen