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Hunting for Use-Wear

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Author(s): Matilda Siebrecht [1] ✉, Diederik Pomstra [2]

[1] Groningen University, Arctic Center, Aweg 30, 9718 CW Groningen, the Netherlands.

[2] Faculteit der Archeologie Universiteit Leiden, the Netherlands.

Investigating use-wear traces on antler and bone harpoon heads from the Dorset cultures using experimental archaeology

Harpoons are an essential part of the hunting toolkit amongst Inuit and have been integral to the material culture assemblage of Arctic groups for thousands of years. The pre-Inuit population known as the Dorset cultures (app. 800 BC–1300 AD) - also sometimes referred to as *Tuniit* - were highly dependent on a maritime subsistence with harpoon heads as one of

the dominant artefact categories at Dorset sites. Although the use of these harpoons is known from historic ethnographic reports observing Inuit hunting techniques and comparison with modern harpoon styles, a preliminary study by Siebrecht suggests there is little evidence of this use found on the surface of archaeological harpoon heads in terms as microscopic use-wear. This contrasts with other studies investigating bone projectiles, which did identify traces of use after experimentation with replica objects. The present study therefore aims to investigate this disparity using several replica harpoon heads made of bone and antler to experimentally harpoon a seal carcass to determine the extent to which use-wear is formed when harpooning a marine mammal.

> “Interpreting the possible uses of tools in the past can only be achieved through a direct comparison with experimental replicas used in documented actions that lead to the creation of specific microwear traces.

Introduction

Dorset cultures were spread throughout the Canadian Arctic and Greenland between 800 BC and 1300 AD (Friesen and Mason, 2016). There is considerable academic discussion surrounding Dorset society, focusing especially on topics such as social organisation, the reason for their disappearance, and the nature of their development from pre-Dorset cultures. However, a general point of agreement is that Dorset material culture has always been considered geographically, and even to some extent temporally, uniform (Maxwell, 1985).

In order to investigate this supposed uniformity, a recent study (Siebrecht *et al* forthcoming) examined the organic artefact assemblages from three sites in the Foxe Basin region of Arctic Canada (See Figure 1), often described as the “core area” of Dorset cultures (Maxwell, 1976, Savelle and Dyke, 2014). These sites, which covered all time periods within the Dorset period, were Needle Point on Rowley Island (NgFv-4, -6, -7, -8, -9, -10), Qulliapik on Mansel Island (JlGu-3) and Kapuivik on Jens Munk Island (NjHa-1).

The study focused on a microwear analysis of the harpoon heads and the needles. This is an investigative method using microscopic analysis to determine how archaeological objects were manufactured and used. These tools are the two prominent artefact categories found in nearly all Dorset assemblages (LeMoine, 1994). In the case of the harpoon heads, this prominence is attributed to Dorset subsistence patterns, as Dorset cultures regularly hunted marine mammals such as seal and walrus (Betts, 2016; Ryan, 2016). The prominence of needles is related to the essential role of animal skins in providing shelter and clothing in Arctic regions (Appelt *et al.,* 2016). Both artefact categories were manufactured from organic materials – predominantly bone, antler, and ivory – with the common addition to the harpoon heads of a chert end-blade.

The needles from all three sites demonstrated a remarkable complexity of microscopic traces related to both manufacture and use. However, most of the harpoon heads demonstrated relatively little or no identifiable use-wear and so their analysis focused predominantly on traces of manufacture. This absence of wear traces could be explained by their relatively short time frame of use, especially when compared to objects such as needles, which would have been engaged in a regular repetitive action (Rots and Plisson. 2014). In contrast, harpoon heads would have been used in short time frames of intense activity, followed by longer periods of inactivity during storage. It is assumed that use-wear would therefore not be created on a harpoon head to the same extent as a regularly used object such as a needle.

There have been several studies analysing the use-wear created on stone projectile points and discussing the issues of reliability and incorrect identification associated with this topic (cf. Fischer *et al.,* 1984; Shea, 1993; Rots and Plisson, 2014). However, there have been relatively few comparable projects investigating the use-wear created on projectiles made from osseous materials, and none focusing specifically on Arctic projectiles. Additionally, while several studies have aimed to identify the use of bone points as projectiles through an investigation of their microwear (cf. Bradfield, 2015), only a handful have combined experimental archaeology in their investigation (cf. Zhilin, 2017).

This latter study, which investigated Mesolithic bone bow-and-arrow technology at the site of Ivanovskoye 7 (central Russia), identified the following traces created through the experimental use of bone arrowheads: rounding, smashing/chipping of the tip, creation of facets down the sides of the tip, distinct polish (similar to that created after contact with skins), and occasionally course striations. Considering these clear results, it is curious why no significant use-wear could be identified on the harpoon heads from the Dorset artefact assemblages analysed as part of the site comparison project by Siebrecht *et al* (forthcoming).

Another study conducted by Buc (2011) aimed to create a general overview of experimental use-wear on organic materials, part of which involved the use of experimental self-bladed harpoon heads (that is, those pieces with a sharpened point included in the body of the harpoon head) on fish and mammal carcasses. The consequent use-wear observations were mainly rounding, especially towards the tip. While these results might appear more limited than those in the study by Zhilin (2017), it is more comparable with those of the microwear analysis conducted on the Dorset harpoon head assemblage. However, when considering both the limited published experimental data in the broader literature, and the specialised maritime subsistence practices of Dorset cultures, it is necessary to conduct further experiments. For example, the property of the contact material – that is, the material that the object is used against – is a particularly important factor of use-wear creation. Experimental research conducted at Leiden University has created a rich reference collection of bone tools demonstrating the range of contrasting use-wear traces observed after use against different contact materials (Van Gijn, 2006). In lieu of this research, it could be assumed that use-wear traces created through contact with fish or terrestrial mammals might look very different to those created through contact with marine mammals. Experimental data for comparison with

Dorset harpoon heads should therefore be collected in strict adherence to the context of Dorset subsistence practices – i.e. using the artefacts specifically on marine mammals – to achieve valid results.

The present study therefore aimed to use experimental archaeology to answer the following research question: To what extent is use-wear created on harpoon heads that have been used to hunt marine mammals?

Materials

There is a wide range of harpoon head types attributed to Dorset cultures, which can vary both between different regions of the Dorset geographic range and over time between the Early, Middle, and Late Dorset periods (Houmard, 2011). Several different harpoon head types were present at the three sites from the preliminary microwear study: Dorset Type Ha, Dorset Parallel, Tayara Sliced, Nanook Wasp Waist, Dorset Type J, and Pre-Dorset (See Figures 2 and 3).

For the present study, four simple replica harpoon heads were created (see Figure 4), made from caribou antler and seal bone and based on harpoon head types from the Middle Dorset period (Maxwell 1976). The harpoon heads were initially shaped using modern (metal) tools and were then further scraped with a flint blade and ground with limestone to obliterate as many of the modern manufacturing traces as possible. Further details of the effect of these traces on the analysis are discussed below. Two of the replica harpoon heads were self-bladed; 4053 was similar to the Nanook Wasp Waisted type, while 4054 was based on a mixture of Dorset and Thule (the culture which came after Dorset) self-bladed harpoon head types. Although not a typical Dorset shape, the latter piece was included to determine whether, in general, differences could be observed between self-bladed harpoon heads with a smooth body (4053) and those with additional cuts comparable to the addition of an end blade (4054). The other two experimental pieces, 4051 and 4052, included blade slots for chert end blades (included in the photo of 4051); similar to the Tayara sliced type (See Figure 4).

Methods

Microwear analysis was used to investigate the traces of use created on the experimental pieces. As a methodological framework, microwear analysis was originally created for the study of inorganic tool use, including the identification of different types of polish on flint blades, by Semenov (1964). If it is understood that certain actions performed by tools will leave an imprint of these actions on the tool's surface, it is then conversely possible to interpret what actions were undertaken by a tool based on the microscopic traces created through these actions. Since its introduction into archaeological research, microwear analysis has become an established methodological framework through which to investigate artefacts and has expanded from the almost exclusive study of flint tools to include organic materials such as bone, antler, and ivory.

Experimental archaeology is an essential part of microwear analysis, as it provides a comparable reference when identifying microwear traces (Gates St-Pierre, 2018). Interpreting the possible uses of tools in the past can only be achieved through a direct comparison with experimental replicas used in documented actions that lead to the creation of specific microwear traces. Before the experiments for the present study were completed, each harpoon head was analysed using a Leica DM 1750M metallographic microscope. Photos were taken of the prominent areas on the harpoon heads - including the tip, central ridge, blade edge, and shaft end - using a Leica MC120 HD camera. The same areas were also photographed after the experiments to allow for a comparison of microwear traces present before and after harpooning. This enabled the elimination of traces related to the natural antler and bone material, rather than as a result of human manipulation through use. It also ensured that any fresh use-wear traces would not be confused with the original manufacturing traces, which also prevents the data from being biased by those modern tool traces not eliminated by the later stages of scraping and grinding.

The harpoon shaft and foreshaft were made from wood (See Figure 5) and allowed for the toggling motion that is typical of Dorset harpoon heads (Maxwell, 1985). The goal was to use the harpoon to pierce a carcass and pull on the cord attached to the toggled harpoon head in order to achieve comparable use-wear that might be created during a 'real' hunting experience. A truly realistic experiment to determine the extent of use-wear formation on harpoon heads would involve the use of experimental harpoons in real hunting situations with live animals, and modern hunters who are expert at using harpoons. However, this more active approach to the experiment conflicts with many ethical considerations as the use of stone tools could be seen as a less efficient method of slaughter. Additionally, the difference in tool material could affect the expertise of a modern hunter. Although Inuit often still use harpoons when hunting, these include harpoon heads made from metal, rather than the chipped stone end-blades of Dorset harpoons, and are less commonly used in present society than they would have been in past Dorset communities.

All experiments were conducted by the authors. The harpoon was used in a thrusting motion at close range, rather than in the manner of a throwing harpoon, which is used generally on larger marine mammals such as whales. The remains of a harbour seal[1] , composed of meat-covered bones wrapped in a meat- and blubber-layered skin, was used as the subject of the harpooning actions. This fabricated "carcass" was placed in a hole on top of a pile of springy branches, with the idea that this would yield slightly to the pressure of the harpooning action and thus would replicate the properties of a seal suspended in water.
This strategy was later adapted, after the first attempts at piercing the fabricated "carcass" proved to be unsuccessful. If the harpoon hit a piece of bone, even without piercing the skin,

the end blade was immediately loosened from the harpoon head. Because the bones were not in their original skeletal frame, their location could not be predicted in the same way as a complete seal body. For this reason, the bones were discarded and the skin, which retained a significant amount of meat and blubber, was stretched over the entrance to the pit, with enough tension to enable the harpoon heads to pierce through the skin and complete the toggling motion (See Figure 6).

This method proved successful, and approximately 100 piercings were completed with each harpoon head. Unfortunately, the main harpoon shaft split toward the end of the experiments, and the last two harpoon heads were pushed by hand through pre-existing holes to create a comparatively similar pattern of use-wear. The pit was approximately 30 centimetres deep, to ensure that if the harpoon heads went completely through the meat and blubber layer beneath the skin, they would not strike anything in the pit walls or floor that could cause the creation of additional use-wear traces. Because the bones were removed, the harpoon heads did not come into contact with bones during the experiments, after the first few unsuccessful attempts of piercing the makeshift "carcass". This therefore eliminated the possibility of creating any use-wear traces that might result from such contact with bones, however it was decided that any traces resulting from contact with the seal skin, meat, and blubber should provide a sufficient comparative reference.

Results

Although two of the experimental pieces included chert end blades, only the bone and antler bodies of the harpoon heads were analysed in the present study, in accordance with the experience of the first author and the focus of her PhD research. In general, very little use-wear was created on the experimental harpoon heads, although some differentiation could be observed when comparing the two types of harpoon heads used in the experiments. The two harpoon heads that included a blade slot showed no clear creation of use-wear traces, while some polish could be observed on the surface of the two self-bladed harpoons.

On experimental piece 4051, the main noticeable difference was a slight dulling of the surface following experimentation (See Figure 7). However, there was no discernible additional directionality besides that already created during manufacture, and no additional polish created through contact with the seal carcass (skin, blubber, and meat). The striations visible in the images were present before experimentation and are clearly a result of the manufacturing process rather than use. The colour change observed between the 'before' and 'after' images is due to different microscopic light settings. It was not possible to replicate the same colour settings for the second batch of images, as access to the microscope was limited by a lab-based schedule and so the two analyses were conducted at different times of day (and thus had variation in the amount of external daylight diffusion). Additionally, the lighting settings on the microscope are adjusted by different users and we could not find our original configuration (future experiments should ensure that the same settings and external lighting is used). Although this did cause a colour change, the contrast in terms of use-wear visibility remained the same.

The same results were observed on experimental piece 4052 (See Figure 8). Although the polish visible before experimentation remained on the surface in places, particularly around areas such as the line hole and the foreshaft slot, the areas towards the blade slot and on the upper sides of the harpoon head were duller, with no creation of new polish. There was also no further creation of directionality from the action of harpooning, for example in the form of striations, despite the repetitive nature of the experiments.

In contrast, the two self-bladed harpoons did demonstrate use-wear production. On experimental piece 4053, areas of dull, smooth polish were created on the highest points of the object's topography, for example at the back of the middle ridge and on the 'shoulder' leading into the pointed tip (See Figure 9). However, this polish was the only use-wear trace created and was not present in the other areas of the harpoon head. There was no additional directionality observed to that already formed during the manufacturing process.

A similar smooth polish to that created on experimental piece 4053 was observed on experimental piece 4054, particularly around the tip of the harpoon head (See Figure 10). However, in the other areas of the harpoon heads, for example on the sides and towards the foreshaft slot, the surface was slightly duller than that seen before experimentation, similar to the observations from 4051 and 4052. There was also no creation of any additional directionality to that formed during the manufacturing process.

Discussion

The results of the experiments demonstrated that very little use-wear was created using a harpoon, even one that was used for 100 'thrusts' into a makeshift seal carcass. What little use-wear that was created formed only on the more prominent areas of the self-bladed harpoon heads, and was limited to the formation of a dull, smooth polish. In terms of directionality, there was no clear creation of traces such as directional polish or striations. These results can be correlated with a lack of clear use-wear visible on the archaeological material. Although it was possible to identify manufacturing traces on artefacts in the Dorset harpoon head assemblage, it was not possible to investigate distinctions or patterns in how the artefacts were used, as there was insufficient use-wear to enable such an investigation. This is understandable if insufficient use-wear was formed during the original harpooning action, as suggested here.

These results do not correlate with the results of other use-wear projects, such as those by Zhilin (2017), where clear traces such as rounding and striations were identified following experiments with bone and antler projectiles. However, in those experiments, projectiles were propelled using bow-and-arrow technology, the increased speed of which could cause the creation of additional traces such as striations. Instead, the results of our experiment are comparable to Buc (2011), who used their replica projectiles with a mixture of bow-and-arrow and hand-thrust spearing experiments. According to the study, these actions did not create striations, only surface rounding, which is more comparable to the minimal creation of a smooth, dull polish observed during our experiments.

Another reason for the results contrast could be the difference in artefact morphology and thus its interaction with the contact materials – i.e., the animal carcass – between the materials in the present study and those outlined above. In the latter, all objects were made solely of antler or bone, including the point and thus the area of impact. However, for the present study, the archaeological assemblage mainly consisted of harpoon heads with blade slots that would have held a lithic end blade. This end blade therefore receives the main force of the impact and so is the most prominent area for the formation of any consequent use-wear traces. The main body of the harpoon head, made from bone or antler, would therefore not demonstrate the same use-wear traces in comparison with those traces evident on the experimental pieces made only (thus in both body and tip) from bone or antler.

This suggestion is supported further when comparing the results from the self-bladed versus the end-blade harpoon heads in the present study. On the self-bladed experimental pieces 4053 and 4054, it was possible to discern the formation of a dull, smooth polish on the most prominent regions of the harpoon head surface, for example around the tip and on any raised ridges. These results can be compared positively with those from the previous studies, as discussed above, although the polish created on our pieces was limited to only a few regions of the harpoon head surface.

While polish was created on the self-bladed experimental harpoon heads, no significant use-wear was observed on those experimental harpoon heads with a blade slot; 4051 and 4052. This result fits with the interpretation suggested above; use-wear traces will not be created to the same extent on those pieces with an end blade, as it is the end blade that is the most prominent point and will consequently demonstrate the most use-wear creation. A similar lack of traces in harpoon heads with a blade slot in the archaeological collection is therefore to be expected. Considering that the majority of the archaeological harpoon heads included a blade slot, the lack of use-wear traces observed in the whole archaeological assemblage correlates with the results of the present experimental study. Due to time and material expertise restrictions, a microwear investigation of the chert end blades from archaeological assemblages has not been and will not be undertaken. However, a further experimental study incorporating a cross-craft microwear analysis of these artefacts would be highly beneficial to future research on harpoon head technology. Another possible reason for this lack of traces is related to the nature of harpoon head use in practice. Hunting activities do not require a continuous and repetitive action, as is the case with the use of needles when sewing. Instead, hunting weapons such as harpoon are used for a single period of high intensity activity, which is then repeated relatively few times and interspersed with longer periods of non-use, for example between hunting seasons.

The results of this study should not be used to dismiss the viability of future research projects investigating the technological traditions associated with harpoon heads. Although microwear analysis may not provide as complete an understanding of harpoon head use during the Dorset period as other artefacts – such as needles – research into this topic can be primarily informed by the use of historic and modern ethnographic accounts. Although Dorset have no genetic or cultural link to historic Inuit, the latter inhabit the same environmental context and are therefore considered more similar in terms of subsistence strategy and general social organisation than other ethnographic populations. They provide the most relevant ethnographic analogy for a further investigation of Dorset hunting practices. The input of expert knowledge from modern-day Inuit hunters could provide some further information relevant to the present study, for example to broaden our understanding of what types of harpoon heads were used for different tasks. While both authors have experience in experimental archaeology (Siebrecht is an experimental archaeologist and microwear specialist, and Pomstra is a prehistoric technology expert), neither had previous experience with the harpoon types used in the present study. Collaborating with expert hunters who have this experience in harpoon use would therefore be extremely beneficial to future studies.

This last point relates to our observations of the practical skills required when using a harpoon. Initial attempts at piercing a fabricated carcass made from bones and meat wrapped in skin were unsuccessful. This was due mainly to the inability of the experimenters to correctly pierce an area of skin that was not hiding a bone, which would consequently dislodge the end blade from the harpoon head and sometimes also the harpoon head from the foreshaft. Future experiments expanding on the current research should, if possible, include an intact seal carcass, which was unavailable for the present study. (This would also allow the observation of possible use-wear traces created on the harpoon heads following potential contact with the skeletal structure). It is assumed that, on a complete and living animal, the configuration of bones beneath the skin would be more predictable than in the initial bundle created as part of the experiments undertaken here, and any harpoon thrusts could be made in a more efficient manner.

This study highlights the facts that a high level of skill would have been required by the hunters, both in using the harpoon as well as in its manufacture. They would have needed to hit their prey in the perfect spot to allow the harpoon head to enter the flesh of the animal and toggle, thus holding it in place, without hitting a bone and thus risking breakage. Additionally, when constructing the complete harpoon, precision is required when constructing all elements in order to prevent parts dislodging at inopportune moments: for example, a sufficiently tight fit must be created between the harpoon shaft and the foreshaft, the foreshaft and the harpoon head, and the harpoon head and the end blade.

The physical connection between the harpoon head and the end blade is particularly interesting. According to archaeological evidence and historical accounts, there is no evidence of an adhesive being used to keep the end blade in place. Instead, the harpoon head would be shaped according to the dimensions of the end blade, which could be wedged into the blade slot in such a way that it would be immovable, often using water and ice as a kind of bonding agent (Rast 2019 pers. comm.). (It should be noted here that this additional use of water and ice was not implemented in the present study and would be an interesting addition to future experimental research on this topic). In order to achieve this precision of fit, the Dorset harpoon maker – which we might assume is also the hunter – would therefore need to have had a good knowledge not only of flint knapping but also antler and bone carving.

This idea of cross-craft interaction, where multiple materials and crafting processes are combined in the creation of a single object, is essential when investigating complex technologies such as harpoons. Based on the experiences related to issues in experimentation – where the harpoon blade would fall out of the slot, or the shaft would split – it is likely that Dorset hunters would have had to make short-term repairs to all parts of the harpoon during a hunting session. A working knowledge of the properties of chert, antler, bone, and wood was therefore an essential part of the hunting activity, in addition to expertise in successfully finding, luring, killing, and processing an animal.

Conclusion

All the experimental harpoon heads were used at least 100 times in harpooning experiments with a makeshift seal carcass. Despite this relatively intensive use, very few use-wear traces were created, which suggests that use-wear is formed only to a limited extent on harpoon heads used to hunt marine mammals. These results contrast with the results of previous studies investigating organic projectile technology. This disparity is due most likely to differences in the methods and materials between the present study and others, such as in the context of object use, the intensity of object use, or the morphological characteristics of the objects.

Although this study has presented evidence for the limitations of microwear analysis as a primary method of research for Dorset harpoon heads, it has demonstrated the contribution that experimental archaeology can add to future Dorset research. At the current time, there is very little published experimental research based on archaeological material culture assemblages in the Arctic. However, the results presented here suggest several possibilities related just to the future study of Dorset harpoon heads, such as further experiments focusing on harpooning skill, and deeper investigations of cross craft interaction. Considering the range of expansion possible within this one material category, there is potential for an even wider range of research topics if we apply an experimental archaeology framework to an investigation of Dorset material culture assemblages.

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1 All of the seal material used in the experiments was donated by the Pieterburen seal sanctuary in the Netherlands. All seals died from natural causes, and no animals were harmed as a cause of or in order to achieve the results of the present study.

Keywords hunting
use wear analysis
organic material
material culture

Country Canada
Greenland

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Corresponding Author

Matilda Siebrecht
Groningen University
Arctic Center
Aweg 30
9718 CW Groningen
the Netherlands
E-mail Contact

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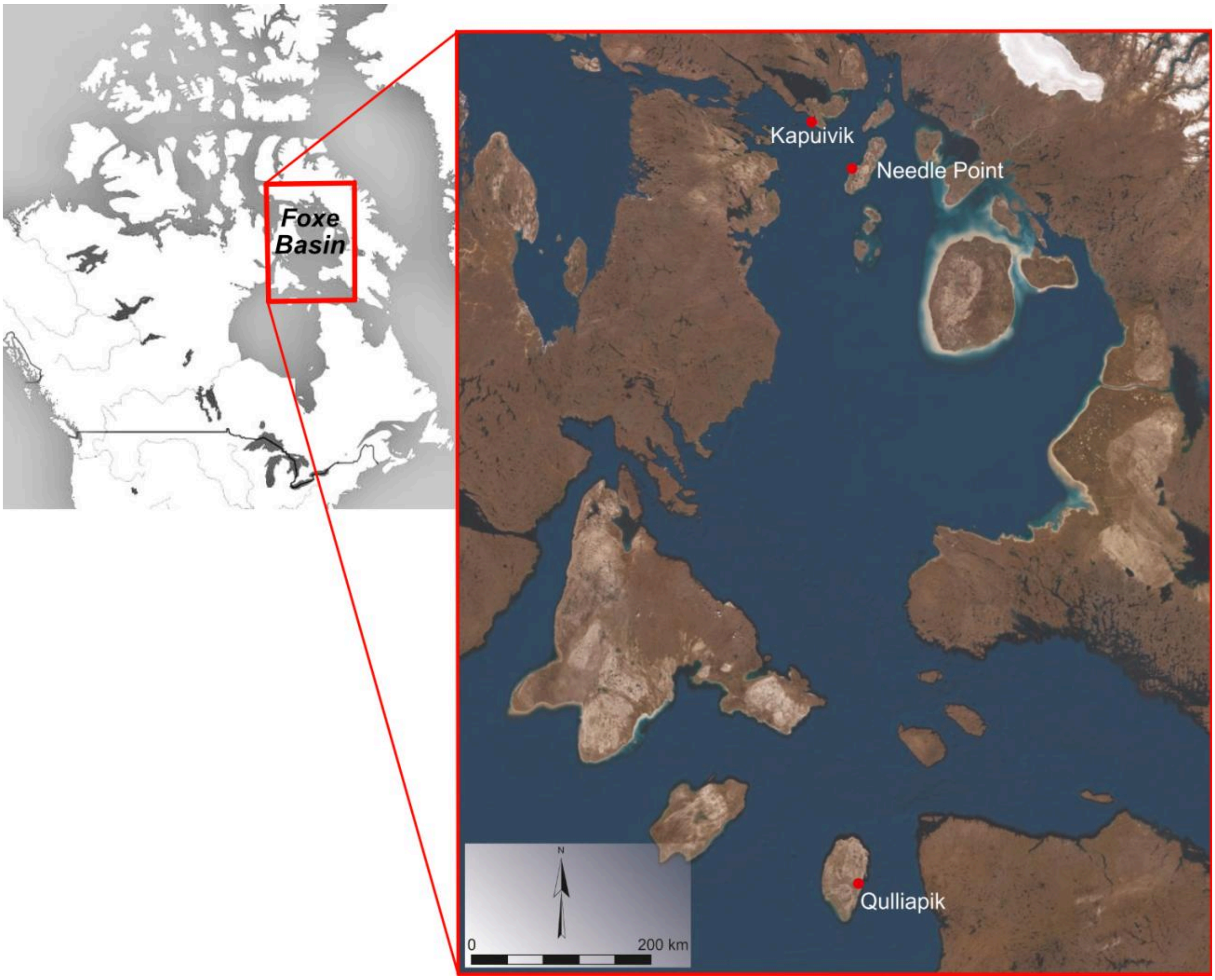

FIG 1. MAP SHOWING THE LOCATION OF ALL THREE SITES FROM THE COMPARISON STUDY (TAKEN FROM SIEBRECHT ET AL FORTHCOMING)

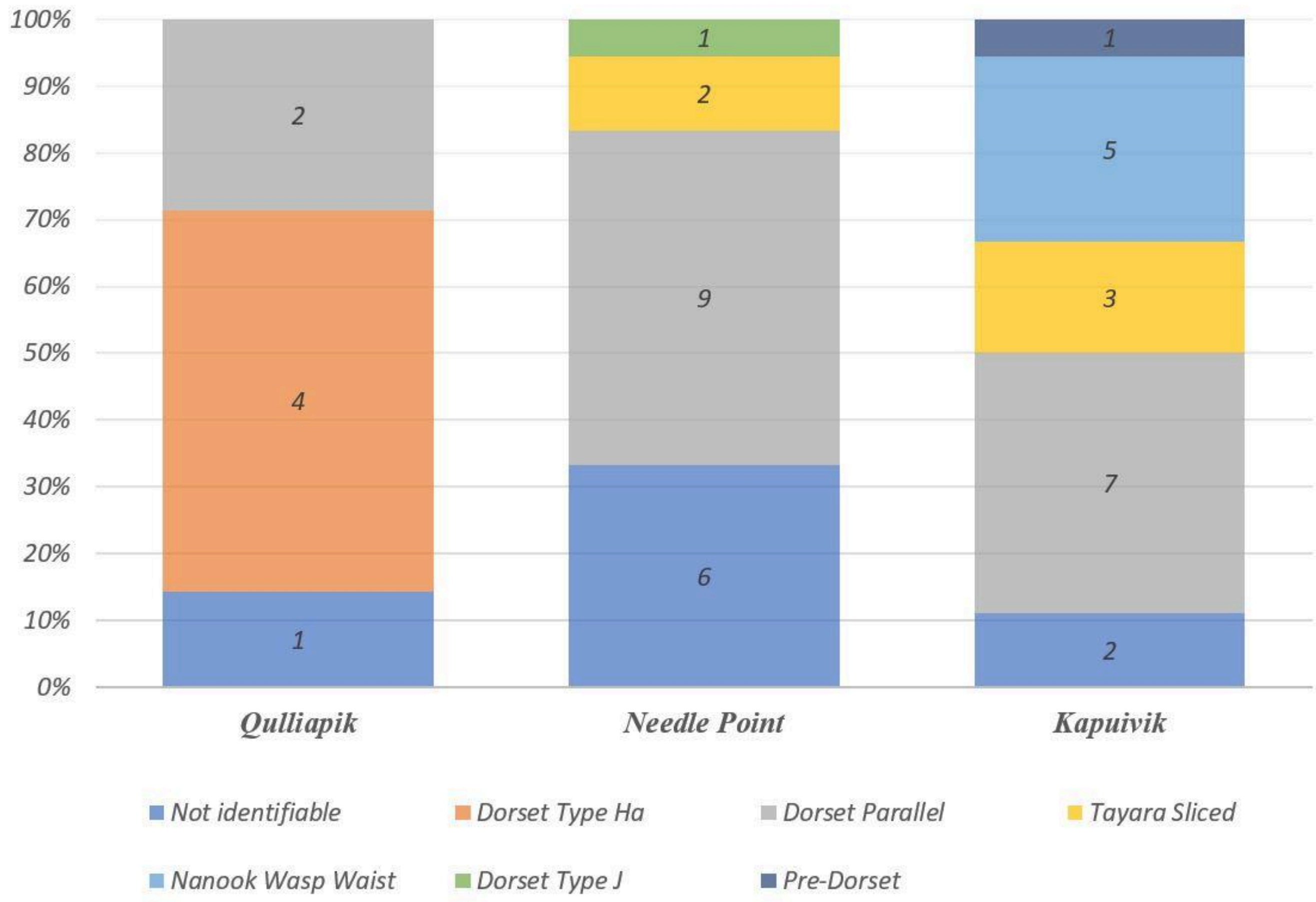

FIG 2. THE DIFFERENT HARPOON HEAD TYPES FOUND AT THE THREE SITES IN THE FOXE BASIN (TAKEN FROM SIEBRECHT ET AL FORTHCOMING)

FIG 3A. EXAMPLES OF DIFFERENT TYPES OF DORSET HARPOON HEADS (PHOTOS COURTESY OF SUE LOFTHOUSE (NGFV8), KATIE KOTAR (NJHA1), SARAH HAZELL (NGFV10), AND ELSA CENCIG (JLGU2)).

FIG 3B. EXAMPLES OF DIFFERENT TYPES OF DORSET HARPOON HEADS (PHOTOS COURTESY OF SUE LOFTHOUSE (NGFV8), KATIE KOTAR (NJHA1), SARAH HAZELL (NGFV10), AND ELSA CENCIG (JLGU2)).

Dorset Parallel (NjHa1 122)

FIG 3C. EXAMPLES OF DIFFERENT TYPES OF DORSET HARPOON HEADS (PHOTOS COURTESY OF SUE LOFTHOUSE (NGFV8), KATIE KOTAR (NJHA1), SARAH HAZELL (NGFV10), AND ELSA CENCIG (JLGU2)).

FIG 3D. EXAMPLES OF DIFFERENT TYPES OF DORSET HARPOON HEADS (PHOTOS COURTESY OF SUE LOFTHOUSE (NGFV8), KATIE KOTAR (NJHA1), SARAH HAZELL (NGFV10), AND ELSA CENCIG (JLGU2)).

FIG 3E. EXAMPLES OF DIFFERENT TYPES OF DORSET HARPOON HEADS (PHOTOS COURTESY OF SUE LOFTHOUSE (NGFV8), KATIE KOTAR (NJHA1), SARAH HAZELL (NGFV10), AND ELSA CENCIG (JLGU2)).

FIG 3F. EXAMPLES OF DIFFERENT TYPES OF DORSET HARPOON HEADS (PHOTOS COURTESY OF SUE LOFTHOUSE (NGFV8), KATIE KOTAR (NJHA1), SARAH HAZELL (NGFV10), AND ELSA CENCIG (JLGU2)).

FIG 4A. THE EXPERIMENTAL HARPOON HEADS.

4052 - seal bone harpoon head with blade slot

FIG 4B. THE EXPERIMENTAL HARPOON HEADS.

4053 - self bladed seal bone harpoon head

FIG 4C. THE EXPERIMENTAL HARPOON HEADS.

4054 - self bladed antler harpoon head

FIG 4D. THE EXPERIMENTAL HARPOON HEADS.

FIG 5. THE TOP OF THE COMPLETED HARPOON, INCLUDING A WOODEN SHAFT AND FORESHAFT, AND TWISTED ROPE TO ALLOW FOR THE TOGGLING MOTION OF THE HARPOON HEAD.

FIG 6. THE FINAL EXPERIMENTAL SETUP USED, WITH THE SEALSKIN STRETCHED OVER THE PIT ENTRANCE.

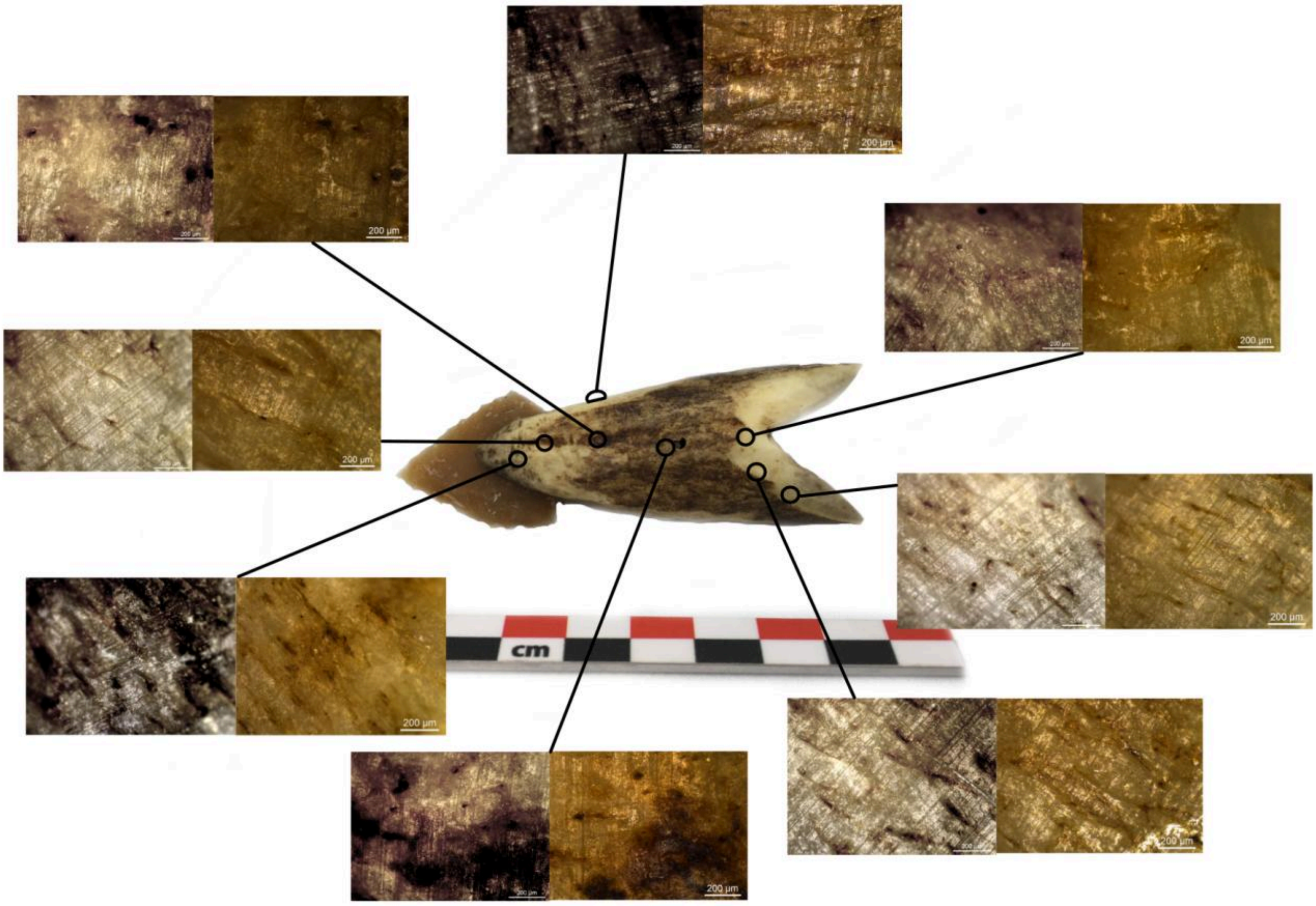

FIG 7. COMPARISON OF THE MICROWEAR TRACES VISIBLE ON HARPOON HEAD 4051 BEFORE (LEFT) AND AFTER (RIGHT) EXPERIMENTATION.

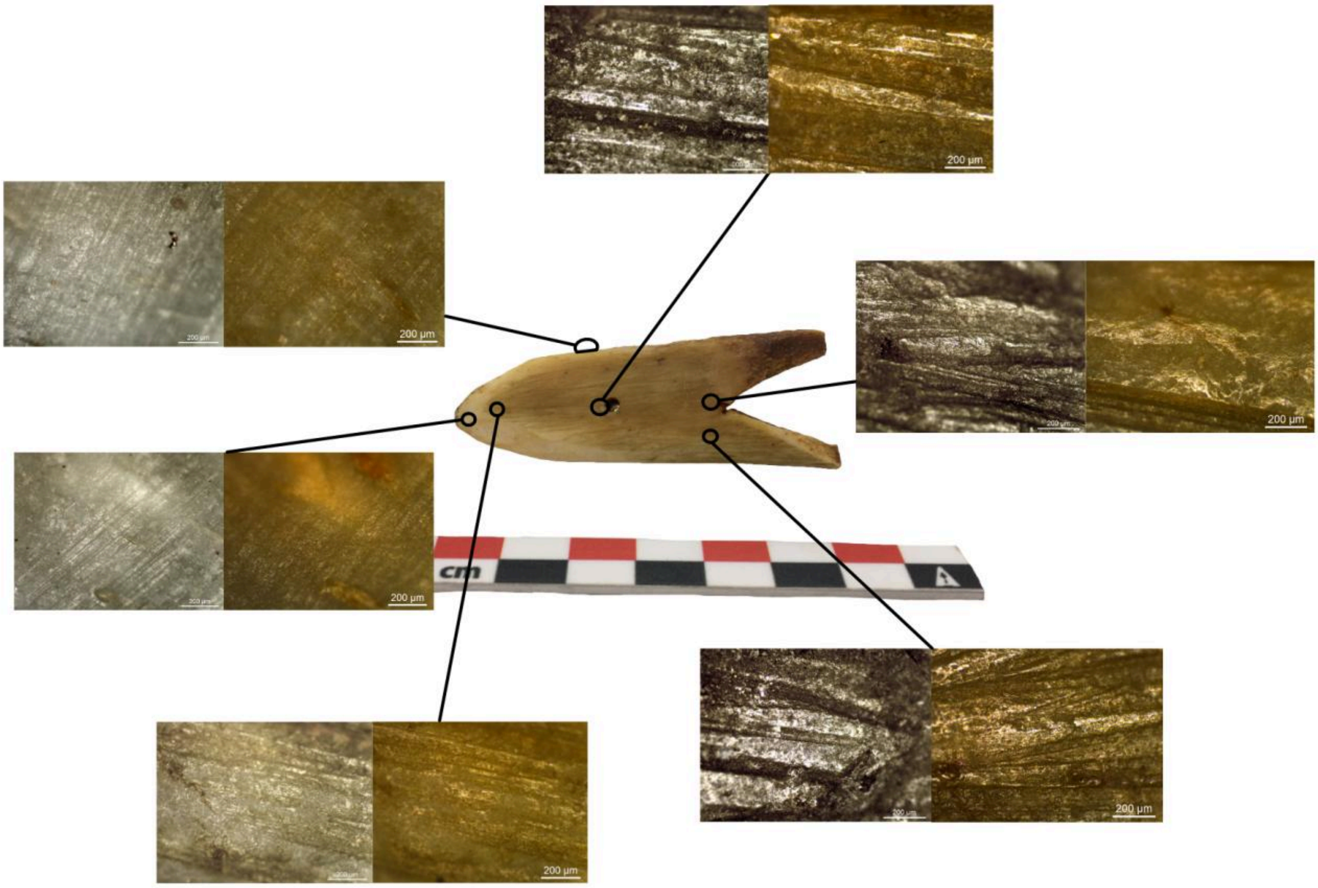

FIG 8. COMPARISON OF THE MICROWEAR TRACES VISIBLE ON HARPOON HEAD 4052 BEFORE (LEFT) AND AFTER (RIGHT) EXPERIMENTATION.

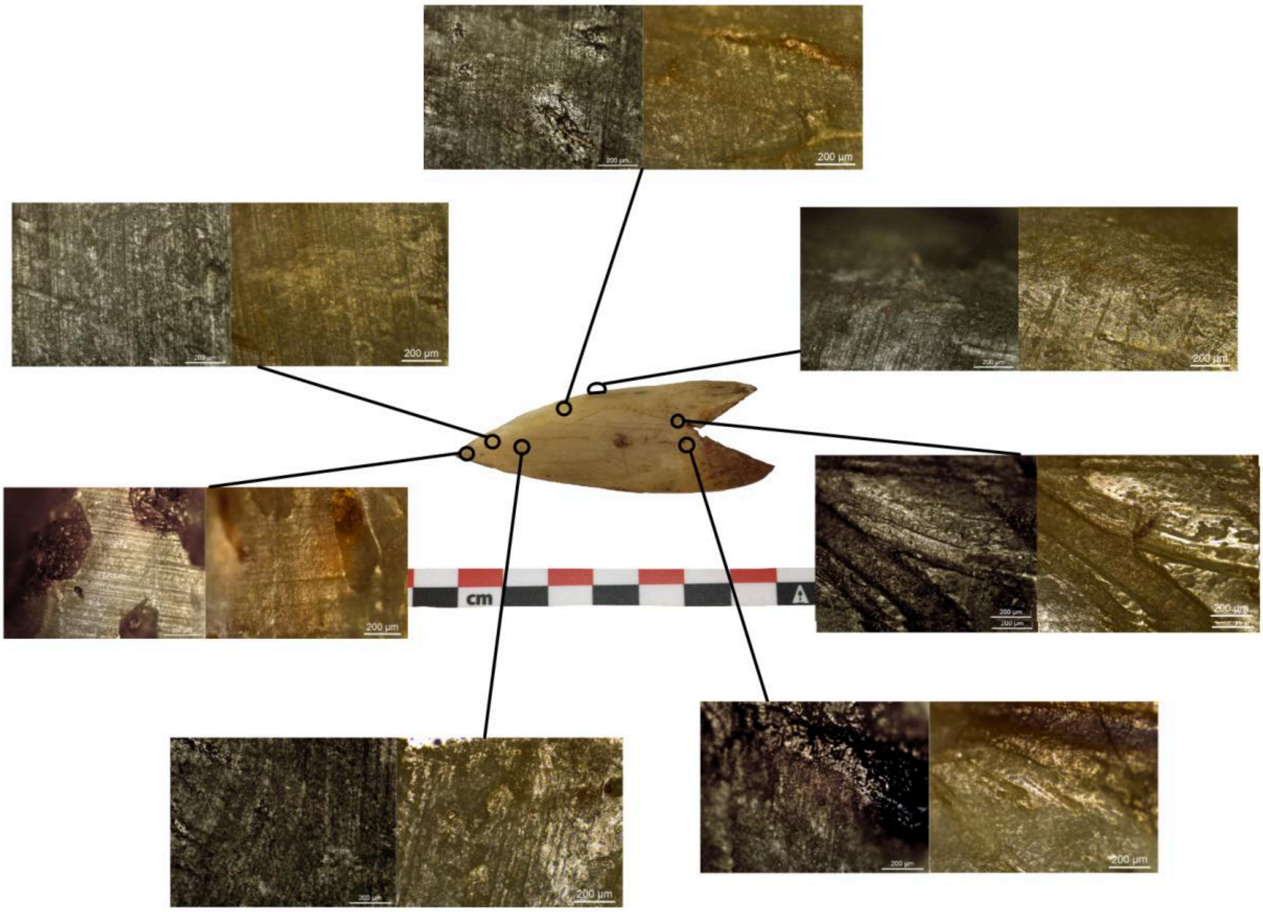

FIG 9. COMPARISON OF THE MICROWEAR TRACES VISIBLE ON HARPOON HEAD 4053 BEFORE (LEFT) AND AFTER (RIGHT) EXPERIMENTATION.

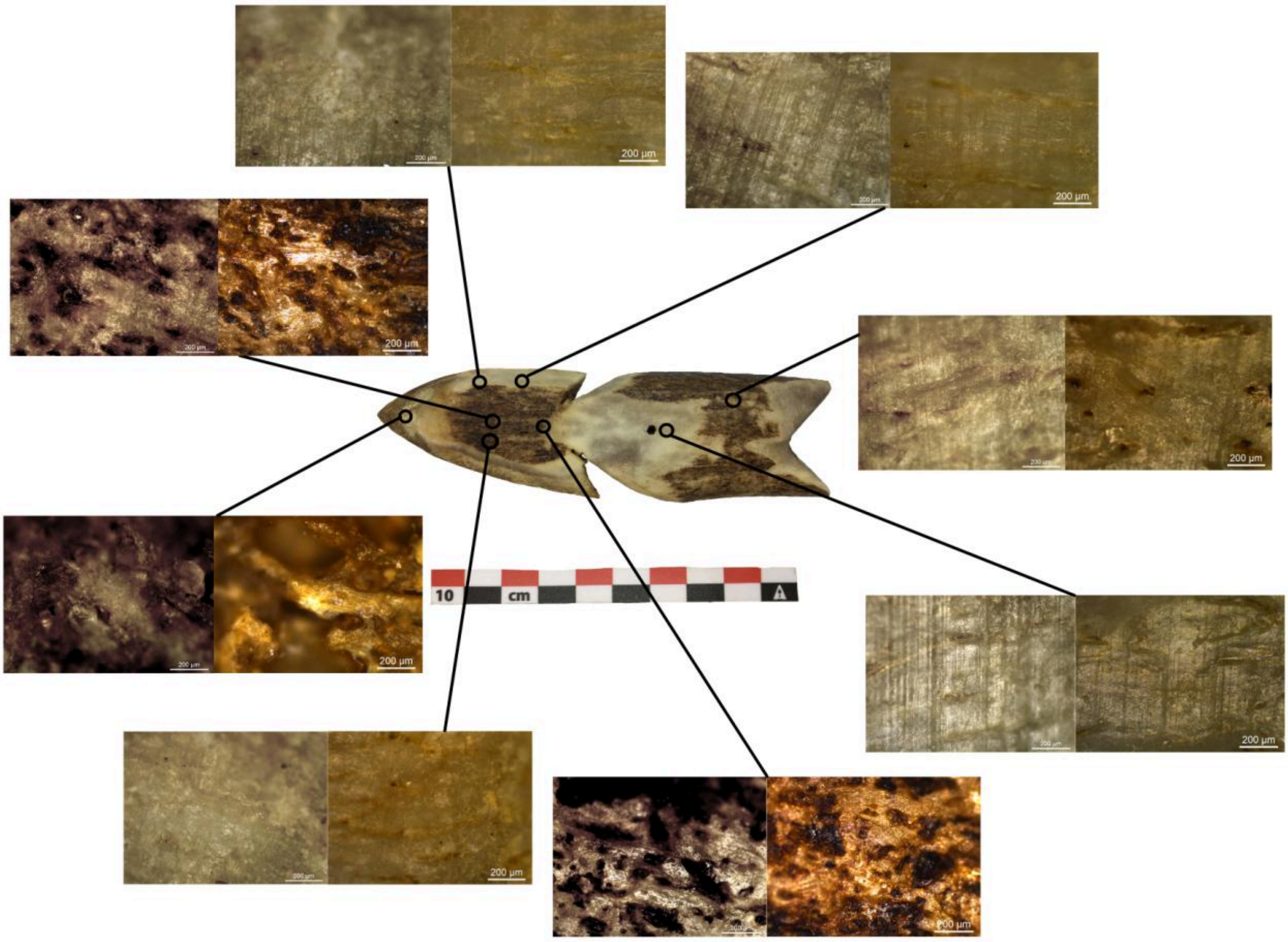

FIG 10. COMPARISON OF THE MICROWEAR TRACES VISIBLE ON HARPOON HEAD 4054 BEFORE (LEFT) AND AFTER (RIGHT) EXPERIMENTATION.