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Of beaver teeth and human hair: A tale of two experiments in usewear analysis

Dents de castor et cheveux humains: récit de deux expériences tracéologiques

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Abstract: Beaver incisors from archaeological sites around the world are often interpreted as woodworking tools such as chisels or side-scrapers. However, this common assumption has never been clearly demonstrated. The first part of this article presents for the first time a detailed usewear analysis aimed at experimentally testing this hypothesis. In the second part, another usewear experimentation describes the characteristic microtraces of bone objects used as hairpins, which may often be confused with bone awls. Together, these two experiments highlight the need for caution in attributing functions to archaeological bone tools in the absence of solid usewear analyses.
Keywords: Experimental archaeology, usewear, function, beaver, hairpin, bone tools, Iroquoians, North America.

Résumé : Les incisives de castor provenant de sites archéologiques de différentes régions du monde sont souvent interprétées comme des outils servant au travail du bois, tels que des ciseaux, des gouges ou des racloirs. Cependant, cette hypothèse courante n'a jamais été véritablement démontrée empiriquement. La première partie de cet article présente, pour la première fois à notre connaissance, une analyse détaillée des traces d'utilisation visant à tester expérimentalement cette hypothèse. Les résultats de cette analyse tracéologique indiquent que le travail du bois crée sur les dents de castor des microtraces d'usure distinctes qui permettent même de distinguer une utilisation comme ciseau d'une utilisation comme racloir, un travail sur un bois dur d'un travail sur bois mou, et un travail sur un bois vert d'un travail sur bois sec. De plus, l'application de ces résultats expérimentaux lors d'une analyse de dents de castor provenant de sites archéologiques iroquoiens du nord-est de l'Amérique du Nord a montré que ces dents pouvaient être des outils multifonctionnels servant à la fois comme ciseaux et comme racloirs, et possiblement pour le travail de matières indéterminées, autres que le bois.
Dans la seconde partie de l'article, une autre expérimentation s'intéresse cette fois aux traces d'utilisation caractéristiques d'objets en os utilisés comme broches à cheveux, qui peuvent souvent être confondues avec des poinçons en os si on se fie uniquement à la forme des objets. Un pattern récurrent comportant une série de traces d'usure spécifiques à chacune des quatre sections principales d'une broche à cheveux en os a pu être identifié. Ce résultat clair permettra à l'avenir de limiter les confusions fonctionnelles entre objets aux formes semblables, tout en permettant d'identifier un type d'objet de parure souvent invisibilisé parmi les assemblages d'objets en os archéologiques. Conjointement, ces deux expérimentations soulignent la nécessité de faire preuve de prudence dans l'attribution de fonctions aux objets en os en l'absence d'analyses tracéologiques ou sur la base d'autres indices moins probants, voire spéculatifs.
Mots-clés : archéologie expérimentale, tracéologie, fonction, castor, broche à cheveux, outil en os, Iroquoien, Amérique du Nord.

INTRODUCTION

Despite the unquestionable development of increasingly advanced methods and techniques in usewear analysis, including the foundational works of specialists such as D. Campana (1989), G. M. Lemoine (1994 and 1997), Y. Maigrot (1997), A. Peltier and H. Plisson (1986), S. A. Semenov (1964), I. Sidéra and A. Legrand (2006), determining the function of bone objects remains a persistent challenge in archaeology. This limitation is partly due to the lack of reference collections, and therefore comparative experimental data, as many bone tool functions have yet to be experimentally documented. Another limiting factor is the restricted access to adequate laboratory equipment and, above all, to researchers with the needed expertise to identify usewear traces on tools. As a result, the determination of the function of bone objects in archaeology is still often based on the shape of the objects, following the assumption that form determines function, as well as on contextual data or ethnographic comparisons. Although these data sets provide useful information about the function of bone objects, best results are obtained when combined with usewear analysis, using a multiple method approach for example (Olsen, 1984; Campana, 1989; Bader, 1992; Coughlin, 1996; Penders, 1997; Byrd, 2011).

In this regard, this article aims to contribute to the usewear reference database for bone tools by presenting the results of two recent experiments concerning beaver incisors and bone hairpins. The first objective is to provide a description of the characteristic usewear traces found on beaver incisors used as woodworking tools, based on an experimentally obtained reference collection. The second objective is to demonstrate that it is possible to identify such specific objects as bone hairpins, also on the basis of experimental usewear data. Although the two-part study presented here stems from the analysis of bone artifacts from archaeological sites in North America, its methodological scope is universal in both cases. It was therefore important to present them together.

These experimental results were applied to archaeological assemblages of beaver incisors from three Iroquoian village sites from end of the Late Woodland (1350 to 1550 AD) located in southwestern Quebec (fig. 1) (fig. 2). Those are the McDonald (Gates St-Pierre and Boisvert, 2018), Mailhot-Curran (Gates St-Pierre and Boisvert, 2015) and Droulers-Tsiionhiakwatha (Boisvert and Gates St-Pierre, 2019) sites discovered in the 1990s and excavated in the 2000s and 2010s. These sites were occupied by populations known as the St. Lawrence Iroquoians, so named because of their concentration along the shores of this major river in Eastern North America. They were sedentary horticulturalists, living in large, sometimes palisaded villages composed of multi-family longhouses. Their subsistence was largely based on the cultivation of maize (*Zea mays*), squash (*Cucurbita pepo*), and common beans (*Phaseolus vulgaris*), supplemented by fishing—with a preference for percids—as well as hunting, which targeted a wide range of fauna, but particularly the white-tailed deer (*Odocoileus virginianus*) and the Canadian beaver (*Castor canadensis*).

The St. Lawrence Iroquoians were also prolific producers of bone and antler artifacts of all kinds, including weapons, tools, utensils, ornaments, and objects of recreational or spiritual function (Jamieson, 1993 and 2016; Gates St-Pierre, 2010; Boisvert et al., 2021). Bone awls are especially abundant (Gates St-Pierre, 2007) and can number in the hundreds within single assemblages. They dominate the three collections considered here, comprising 48% of the identifiable worked bone assemblage from the McDonald site, 37% of the Droulers-Tsiionhiakwatha assemblage, and 43% of the Mailhot-Curran assemblage. Most were made of bone, or sometimes antler, from the white-tailed deer. Modified beaver incisors, for their part, generally constitute the second most frequent category of worked bone, representing 13%, 28%, and 17% of the total number of worked bones from the same three assemblages, respectively (Gates St-Pierre and Boisvert, 2015 and 2018; Gates St-Pierre et al., 2016; Boisvert and Gates St-Pierre, 2019; Boisvert et al., 2021). Modified incisors from other rodent species, such as the Canadian porcupine (*Erethizon dorsatum*) or muskrat (*Ondatra zhibeticus*), are rare.

1. BEAVER INCISORS CONTEXT AND METHODS

Beaver incisors are often found in various archaeological contexts in North America (Tizzer, 1943; Ritchie, 1965; Jamieson, 1993 and 2016; Clermont, 2003; Lyman and Zehr, 2003; Griffiths, 2006; Gates St-Pierre, 2010; Gates St-Pierre et al., 2016; Boisvert et al., 2021), Eurasia (Coles, 2006; Callou et al., 2011; Lozovskaya et al., 2017; Schmölcke et al., 2017; Zhilin, 2020), and South America (Parmigiani and Alvarez Soncini, 2014). They are generally interpreted as woodworking tools, such as chisels or scrapers, based on the morphology and analogical reasoning—that beaver incisors are naturally adapted for wood processing, therefore human use must be similar. However, while this premise is logical, it is largely based on common sense rather than empirical, which remains rare (but see Parmigiani et al., 2023). The present study, part of the second author's Master's thesis at the Université de Montréal under the supervision of the first author (Labonté, 2023), aims to provide such empirical validation.

A total of twelve experiments were conducted using two types of hafted incisors from North American beavers (*Castor canadensis*), a species distinct from the Eurasian beaver (*Castor faber*). The first type, a chisel, consisted of incisors with slightly abraded distal ends to create a smooth and regular surface suitable for observing usewear under magnification (fig. 3, top). The incisor was hafted and the distal end was applied perpendicularly to the surface of a piece of wood, pressed in, and

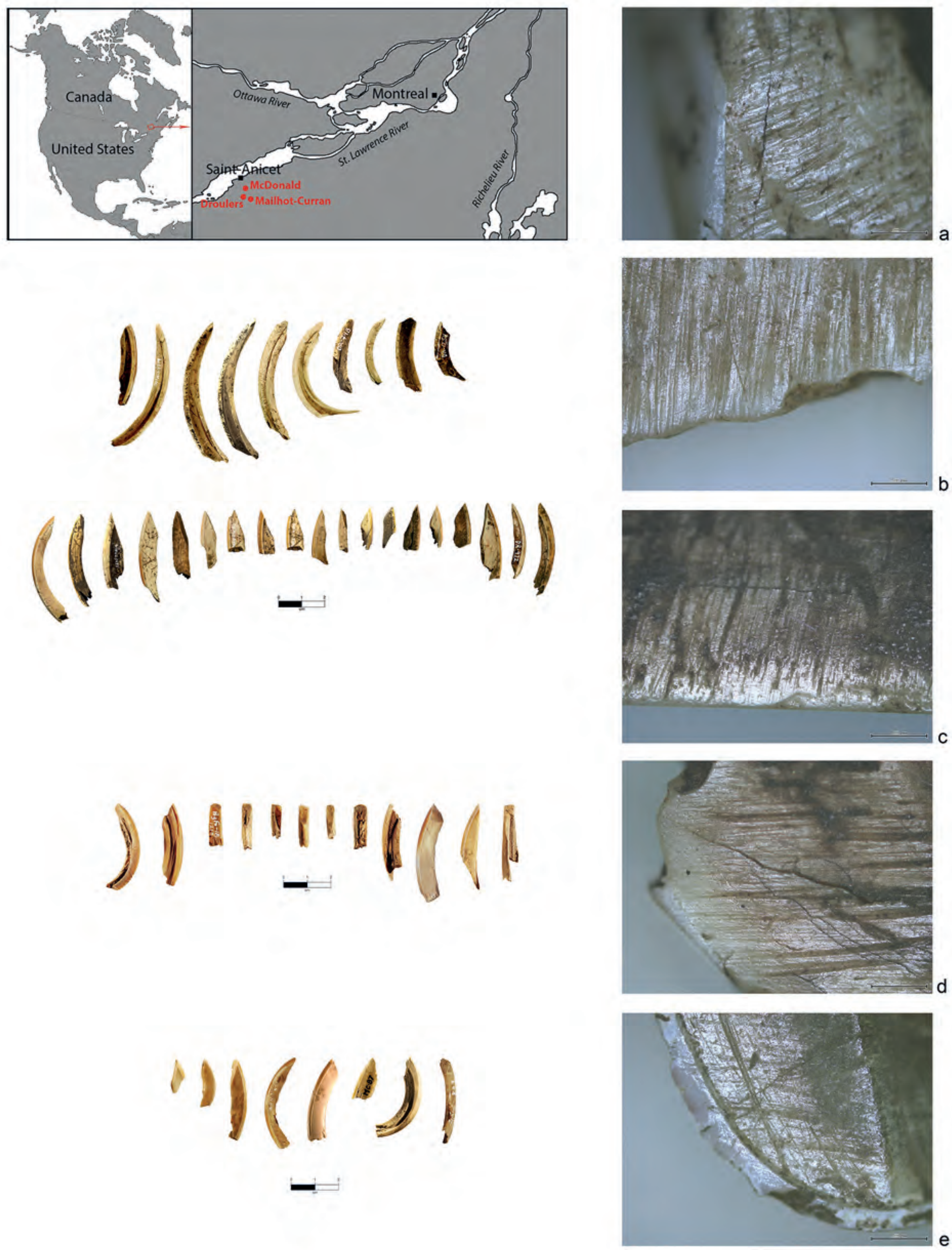

Fig. 1 – Location of the sites mentioned in the text with examples of modified beaver incisors, on the left; two upper rows: Droulers-Tsiionhiakwatha site; middle row: McDonald site; lower row: Mailhot-Curran site. On the right: usewear traces as chisel on soft wood (a, 50×); as side scraper on semi-hard wood (b, 50×); as side scraper on green wood, with residue (c, 50×); as chisel on semi-hard wood (d, 50×); and with a combination of uses as chisel first and later as side scraper as indicated by the different orientation of the striae on hard wood (e, 50×).

***Fig. 1** – Localisation des sites mentionnés dans le texte et exemples d'incisives de castor modifiées. À gauche, deux rangées du haut, site Droulers-Tsiionhiakwatha ; rangée du milieu, site McDonald ; rangée du bas, site Mailhot-Curran. À droite, traces d'utilisation comme ciseau sur bois tendre (a, 50×) ; comme racloir sur bois semi-dur (b, 50×) ; comme racloir sur bois vert, avec résidus (c, 50×) ; comme ciseau sur bois semi-dur (d, 50×) ; et avec une utilisation combinée, comme ciseau d'abord et racloir ensuite, ce que suggère l'orientation différente de stries, sur un bois dur (e, 50×).*

Material tested	Chisel	Side scraper
Fresh, hard wood (shadwood, *Amelanchier canadensis*)	1 (exp. 1)	1 (exp. 2)
Dry, hard wood (white birch, *Betula papyrifera*)	1 (exp. 3)	1 (exp. 4)
Dry, semi-hard wood (red maple, *Acer rubrum*)	1 (exp. 5)	1 (exp. 6)
Dry, soft wood (balsam fir, *Abies balsamea*)	2 (exp. 7-8)	2 (exp. 11-12)
Dry, soft wood (cedar, *Thuya occidentalis*)	1 (exp. 9)	
Antler		1 (exp. 10)
Total	6	6

Fig. 2 – Experimental bone tools used to carve wood as a chisel (top) and to scrape wood as a side scraper (center). Table of materials tested for each experiment (bottom).

***Fig. 2** – Outils en os expérimentaux utilisés à la manière d'un ciseau pour graver le bois (en haut) et à la manière d'un racloir latéral pour racler le bois à la manière d'un racloir latéral (centre). Tableau des matières testées pour chaque expérimentation (en bas).*

drawn downward to remove a shaving. This motion was repeated uniformly in each experiment. The second type, a side scraper, involved incisors abraded along the lateral edge to produce a curved, concave scraping sickle similar to a sickle (fig. 2, bottom a). During the experiments, the scraping edge was positioned obliquely to the surfaced and pulled downward with consistent pressure to detach thin shavings. The same motion was systematically applied to all types of wood in order to limit variability and allow for comparability of the experimental results. For chisels, the distal tip was pressed into the wood at an acute angle and pulled toward the user, lifting thick chips by leverage, whereas for scrapers, the incisor tip was applied at a shallow oblique angle with a unidirectional pull to detach thinner, longer shavings. This differentiation in movement, angle, and pressure was systematically recorded to identify diagnostic wear patterns corresponding to tasks such as scraping, grooving, debarking, and gnawing.

Six chisels and six side scrapers were used on different wood type, including dry (N = 8), fresh (N = 2), hard (N = 4), semi-hard (N = 2), and soft (N = 4). Baseline measurements of the incisor surfaces were taken before experimental use (0 min), followed by recordings at successive intervals of 5, 15, 30, and sometimes 60 minutes (fig. 2, bottom). Usewear progression was systematically documented through notes, photographs, and observations under an Olympus BX-51 metallographic microscope at 12.5×, 50×, 100×, and 200× magnification. One additional incisor was used experimentally on antler. Variations in wood type and condition were deliberately tested to evaluate their effect on usewear formation. Hard, dry woods, such as maple, resisted manipulation, producing only fine particles rather than large bark sections, while soft or fresh wood facilitated more abundant striae and polish. We are aware that the number of experiments conducted per wood type is limited and possibly not entirely representative, although several recurring patterns were observed. Usewear experiments and identifications are, however, time-consuming; a reasonable workload had to be considered within the framework of a Master's thesis by a beginning student.

Finally, microtopography of the active surfaces was also characterized, prior to use. Some incisors exhibited heterogeneous microrelief, with high points flat and smooth on the lingual face and flat but slightly rough on the buccal face, while others showed homogeneous microtopography, with regular high points that were either flat and smooth or rounded and rough. This initial characterization provided baseline criteria to distinguish natural dental morphology from use-induced modifications.

2. BEAVER INCISORS – RESULTS

The usewear produced during the experiments is described in terms of abrasion, polish, striations, chipping, and breakage. Chisel-type incisors exhibited light abrasion and general flattening of the contact surface (fig. 3a). Distinguishing natural from anthropogenic wear was facilitated by microtopographic and microwear analysis. Natural wear manifested as generalized striae predominantly on the lingual surface, with the buccal surface retaining the characteristic microtopography of unmodified beaver incisors. In contrast, anthropogenic use produced task-specific features, including localized polish, edge blunting, and micro-chipping, which allowed clear differentiation in archaeological assemblages.

Polish developed rapidly and was particularly intensive on the higher points of the microtopography with all types of wood, while lower points remained less affected when working harder woods. Striae are abundant, fine, shallow, long, and aligned parallel to the tool's longitudinal axis, reflecting the unidirectional movement applied during the chiseling motion. Like polishing, it appears early and quickly reaches a plateau, after which it does not expand or intensify further. Chipping, on the other hand, became more pronounced over time, detaching large enamel spalls, especially on the sides of the tool where pressure and friction were greatest (fig. 3b).

Side scrapers displayed more intensive rounding of the scraping edge over time (fig. 3c). Polish was bright and extended primarily across high points without penetrating striae or depressions. Striae were abundant, variable in depth, width, and length, whereas chipping was rare and worn away by subsequent abrasion. Occasional cracks and breakage were observed (fig. 3d). In one antler experiment, the scraper broke after less than five minutes, indicating reduced resistance relative to stone tools used for the same purpose, although further experimentation would be warranted to support this hypothesis. Since we were out of incisors, the experiment could not be retried, and because of the limited time of use, usewear did not clearly appear on this specimen and cannot be described.

Progression of use-induced modifications revealed that polish developed more extensively on the lingual surface than on the buccal surface, blunting of high points occurred across the entire incisor, and enamel deteriorated faster than dentine, suggesting differential material resistance. These patterns were consistent with operational mechanics: chisels were applied vertically to lift thicker woodchips using a levering motion, whereas scrapers were applied obliquely to remove thinner wood shavings with a unidirectional pull. Wood type and condition significantly influenced wear formation. Dry, hard maple resisted manipulation, producing only fine particles rather than chips or shavings, while fresh and soft woods generated more striae and smoother polish. Together, these results highlight the interplay between tool morphology, movement, and material properties in producing microwear patterns.

As mentioned in the introduction, these experimental results were applied to archaeological assemblages of beaver incisors from the McDonald, Droulers-Tsiionhiakwatha, and Mailhot-Curran sites, three Iroquoian

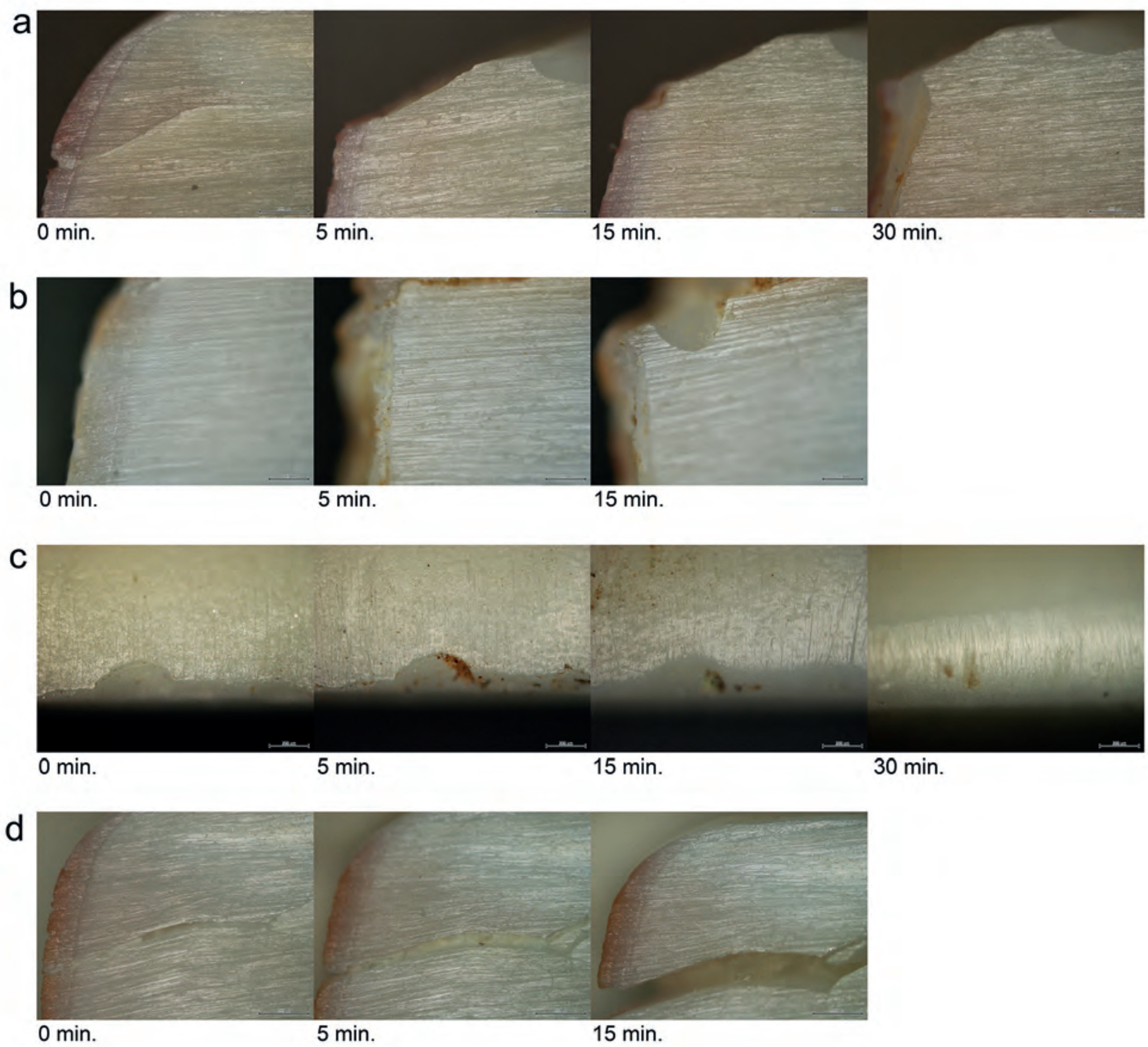

Fig. 3 – Usewear on tools used as chisels on dry and hard wood (a, 50×); on dry and semi-hard wood (b, 100×); on fresh and hard wood (c, 100×); and on dry, soft wood (d, 50×) at time zero (before use) and after 5, 15, and 30 minutes of use.

Fig. 3 *– Traces d'usure sur des incisives utilisées comme ciseaux sur du bois sec et dur (a, 50×) ; sur du bois sec et semi-dur (b, 50×) ; sur du bois frais et dur (c, 100×) ; et sur du bois sec et tendre (d, 50×) au temps zéro (avant utilisation) et après 5, 15 et 30 minutes d'utilisation.*

villages from the end of Late Woodland period (1350 to 1550 AD). Of 214 beaver incisors analyzed, 26 were used exclusively as chisels, 64 as side scrapers, and 70 exhibited both chisel and side scraper usewear, suggesting multifunctionality or recycling. The remaining 54 incisors either did not have any visible usewear or usewear that could not be precisely determined. Most chisels (100%) and side scrapers (97%) exhibited typical woodworking usewear, suggesting these are specialized tools. Finally, some archaeological specimens also retained black residues, likely microscopic wood particles fused to the enamel via frictional heat. Those results are illustrated through a series of clear examples on figure 1.

3. BONE HAIRPINS CONTEXT AND METHODS

Bone awls are a common type of tool found worldwide, and Northeastern North America is no exception. Iroquoian populations living in that area in the past made great use of these objects, which often constitutes the predominant functional category in their bone tool kits (fig. 4). However, it is also a catch-all category uniting objects that appear very simple and similar at first sight—they are all slender with a pointed end—, despite significant variability is length, width, tip angle, raw material (bone or antler) and manufacturing technique.

Fig. 4 – Examples of bone tools classified as "awls" from the Mailhot-Curran (first three specimens on the left) and Droulers-Tsiionhiakwatha sites that may actually represent bone hairpins.
***Fig. 4** – Exemples d'outils en os des sites Mailhot-Curran (trois premiers spécimens à gauche) et Droulers-Tsiionhiakwatha classés comme « poinçon », mais qui pourraient en réalité être des broches à cheveux.*

Actually, several studies have demonstrated that such a large and ill-defined category often includes a variety of objects having quite different functions, such as bodkins, drills, punches, pottery engravers, basket-making tools, corn husking pins, tattooing needles, and multifunctional tools (Chomko, 1975; Breitborde, 1983; Olsen, 1984; LeMoine, 1994; Williamson and Veilleux, 2005; Gates St-Pierre, 2007 and 2018; Mozota and Gibaja, 2015; Bryce, 2016).

Another type of object that can be confused with bone awls is hairpins. Hairpins may be linked to status, gender, or ritual contexts in different cultures, and are thus important objects to consider. They can be quite variable in shape and size, but most of the time they are well-made objects, with straight and regular sides, round shafts in cross-section, they are entirely polished, and sometimes decorated, especially on the proximal end. The shorter version, with a beaded or bulbous proximal end, is often called a bodkin and is usually interpreted as a clothing fastener rather than a hairpin, though the latter possibility cannot be ruled out (Olsen, 1984; Wheeler, 1994; Williamson and Veilleux, 2005; Byrd, 2011). S. L. Olsen (1984) remarked that hairpins do not have usewear on the tip, whereas the shaft is evenly polished. J. C. Byrd (2011, p. 77) states, "logically, if used as hairpins or fasteners, wear should be light and localized mid-shaft", but her results rather concur with S. L. Olsen's, in that she sees no localized wear on the pins she analyzed. However, both cases are based on the observation of archaeological specimens, not on the observation of replicas used experimentally. As also mentioned by J. C. Byrd (2011: 77), there has never been any such experiment using bone hairpins to identify a characteristic usewear pattern, to the best of our knowledge. To address this gap, we conducted an experiment to identify the characteristic usewear patterns of bone hairpins, which provides results opposite to S. L. Olsen's and J. C. Byrd's observations.

We conducted an experiment with four bone pin replicas to determine the characteristic usewear of hairpins. The replicas were made from white-tailed deer long bones and were worn by four different students—including the second author—during various periods of time, inserted in either a hair bun or a pony tail (fig. 5, top). Pin No. 1 was used for a total of 202 hours spread over a period of five weeks; pin No. 2 was worn for 566 hours over height weeks; pin No. 3 was used during 240 hours over

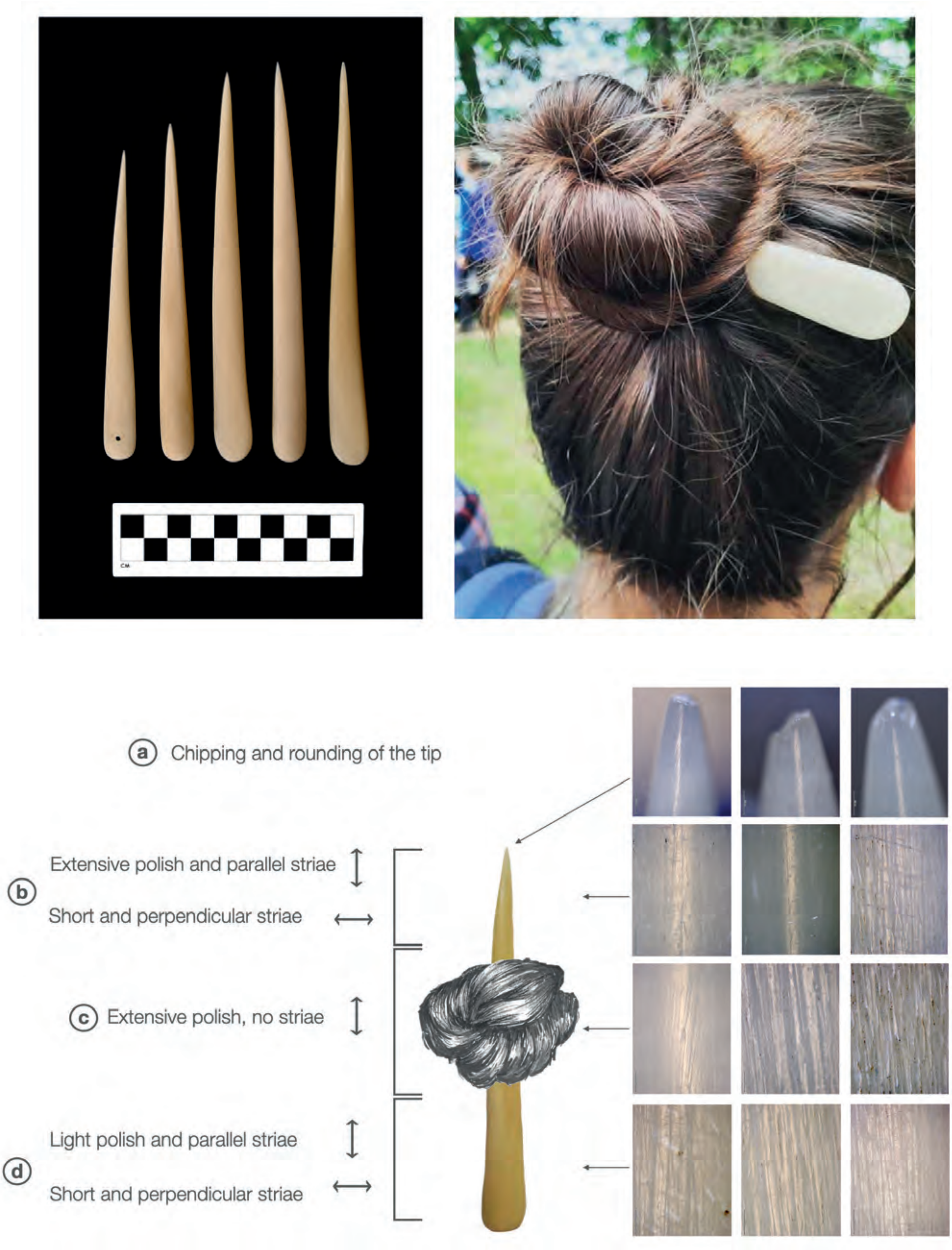

Fig. 5 – Bone pin replicas (a) and a student wearing one of them, inserted into a hair bun (b); Summary of the usewear on experimental hairpins (c; see text for detailed explanations).

Fig. 5 *– Reproductions de broches à cheveux en os (a), l'une d'elles portée dans le chignon d'une étudiante (b) ; synthèse des microtraces d'usure sur les broches à cheveux expérimentales (c; voir texte pour les explications détaillées).*

four weeks; and pin No. 4 was in use for about 720 hours over 12 weeks. For logistical reasons, it was not possible to document the development of the usewear at regular time intervals, contrary to the previous experiment. Thus, each pin was observed, described, and photographed before and after use only, using the same microscope as above. In addition, each pin was inserted approximately 0.8 times per hour, on average. Although some pins were accidentally dropped, none broke. Usewear was documented through notes, photographs, and observations under the same Olympus BX-51 metallographic microscope at 12.5×, 50×, 100×, and 200× magnification.

4. BONE HAIRPINS – RESULTS

The results of the usewear analysis reveal a consistent pattern across the four replicas; therefore, they will be presented together and illustrated in figure 5. From the tip to the proximal end, four distinct sections of usewear can be observed. Repeated insertion of the pin into the compact hairbun causes microbreaks and microchipping at the tip, along with edge rounding and surface polishing (fig. 5, bottom a). An extensive polish develops on the first third of the shaft, accompanied by striae (fig. 5 bottom b). In some cases, the polish follows the microtopography of the surface, partially extending into the large striae formed during pin production. This may result from handling the pin with the fingers, since human skin is known for producing polishings similar to hideworking (Griffits, 2001; Rots, 2004; Ibáñez et al*.*, 2015). Most of the striae are long but variable in length and depth, and most are parallel to the longitudinal axis of the shaft and were created by the insertion of the pin into the tight hairbun. A smaller number of short striae run perpendicular to the shaft's axis, likely resulting from either rotational movement during insertion or contact with objects such as hats or clothing, as this part of the pin is not protected by the hairbun.

The fourth section is the middle part of the shaft. Here, friction from inserting the pin into the hairbun creates a bright polish, limited to the higher points of the microtopography—specifically, the longitudinal and parallel crests between the large striae formed during pin manufacture (fig. 5, bottom c). There are no usewear striae on this section, as the tight hairbun not only prevents movement and friction during use, but also protects this section of the shaft from contact with external elements. The final section is the proximal end, where usewear resembles that of the second section. However, the polish is less extensive, likely because this section rarely enters the hairbun and experiences less friction from hair contact. For the same reason, the parallel striae are less numerous than on other sections. Conversely, some experimental hairpins exhibit a higher number of both long and short striae, oriented perpendicularly or obliquely to the pin's longitudinal axis, likely resulting from handling or contact with external elements.

Taken together, these experimental microtraces form a clear, coherent, and consistent pattern. This pattern is characteristic of bone objects used as hairpins. This is a rare example of a bone tool type that requires examining the entire surface, not just the tip. This may hinder its recognition when analyzing broken, incomplete archaeological specimens. However, complete or nearly complete bone hairpins should no longer be mistaken for awls or other similarly shaped bone tools when microwear analysis is performed. Further research should investigate this issue through similar experiments using other materials, such as antler, and document the gradual development of usewear at regular intervals—something that was not possible in the present study. We will also check for the presence of hairpins among the large assemblages of Iroquoian bone awls to further test the validity of the identified pattern, which will be the subject of another forthcoming article.

CONCLUSION

Archaeologists were correct in asserting that modified beaver incisors from archaeological sites functioned as woodworking tools. However, such claims were previously based only on object form or ethnographic analogy. Now, they can be supported with more reliable data from usewear analysis. Similarly, identifying bone hairpins in the archaeological record can be challenging without robust usewear data like that presented here. This study provides new insights into body ornamentation and care in ancient and recent societies. Ultimately, the continued expansion of experimental usewear databases worldwide will enhance analytical methods, helping to determine and better understand the functions of bone objects in various cultural, chronological, and geographic contexts in the past.

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