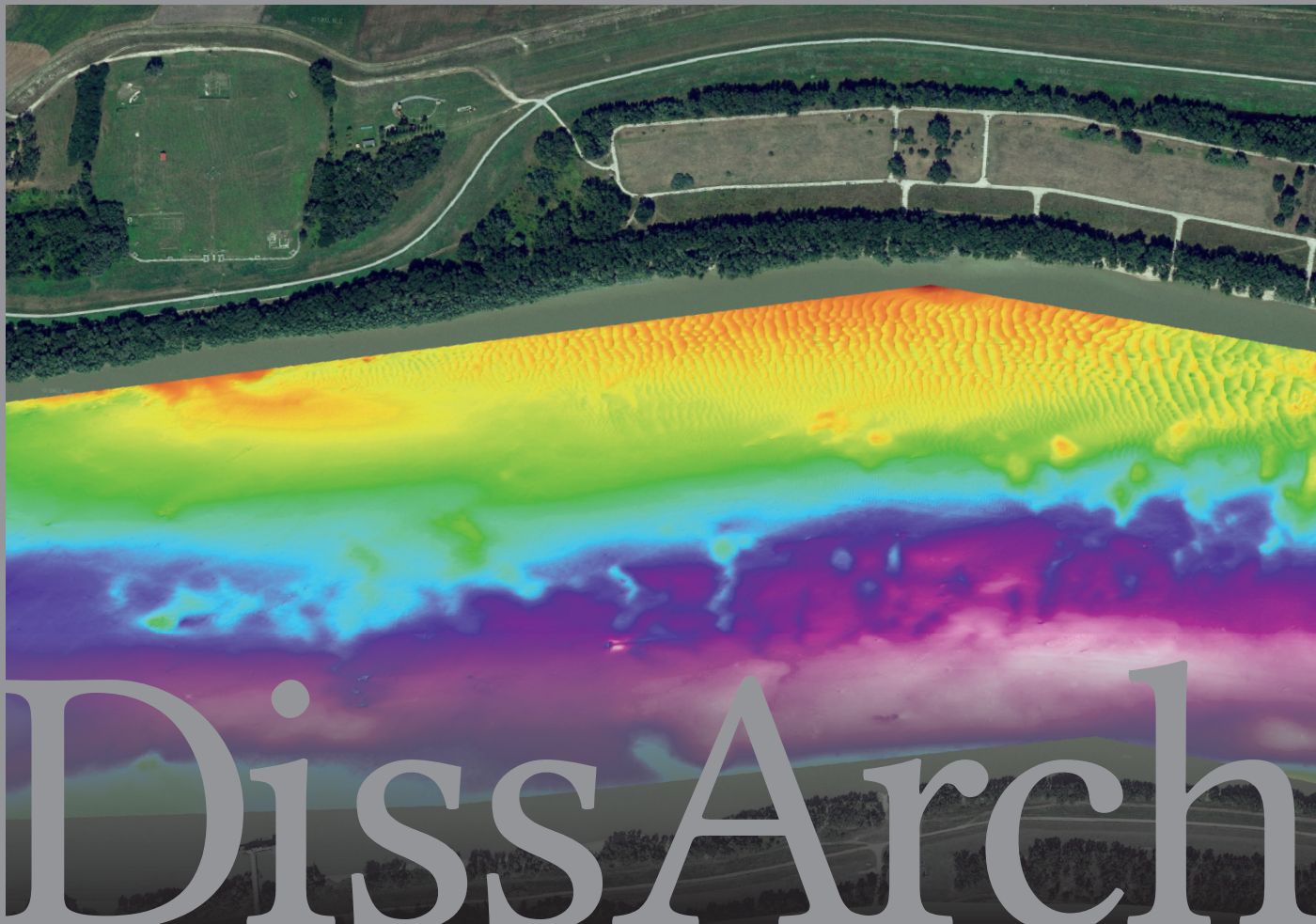


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Possible ways of use of medieval and early modern bone tools based on results of use-wear analysis, experimental archaeology, and ethnographic parallels

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Abstract: A demand has emerged in both Hungarian and international literature for research on the function of a group of rather diverse, yet broadly similar-looking objects made from the long bones of large ungulates, usually referred to as bone skates. These objects were made mainly from metacarpals, metatarsals, or the radius of horses and cattle. Many are perforated in various ways, but there are also some without any perforations. A flat surface can be observed on one side of most pieces—a trait usually considered a prerequisite for identification as skates. The ends of the bones are usually cut to remove the overhanging parts. This paper aims to determine what these bones were actually used for in the Middle Ages and early modern times, relying on use-wear analysis and experimental archaeological methods.

Keywords: medieval bone skates, use-wear analysis, experimental archaeology

Introduction

Bone skates are made of the long bones of large ungulates—mainly horse metacarpi, metatarsi, and radii—but also cattle, rarely donkey and, in Western and Northern European examples, deer bones. The presence of a flat surface is usually the reason for their interpretation as skates.¹ This group of finds attracted the interest of researchers as early as the 19th century, with the focus of research having been the function of these worked bones. Several hypotheses have been published on their possible functions. Publications by foreign researchers include the works of the British Arthur MacGregor and the Soviet Sergei Semenov, who focused on the function of the objects. Hans Christian Küchelmann and Petar Zidarov, who carried out a reconstruction of skates and skating in the early 2000s, are also worth mentioning.²

In Hungary, Ottó Herman wrote several articles on bone skates and similar objects. In the past years, Alice Choyke, László Bartosiewicz, Márta Daróczi-Szabó, and László Daróczi-Szabó also worked with this group of finds.³ István Vörös expressed his doubts about the possibility that the objects made of large ungulates long bones with a flat surface, found in excavations, were used for skating in the past.⁴

1 HERMAN 1887, 172; HERMAN 1902, 7; SCHÖNVISZKY 1932, 17; MACGREGOR 1976, 58; PETÉNYI 1994, 111; BARTOSIEWICZ 2006, 180–181; DARÓCZI-SZABÓ – DARÓCZI-SZABÓ 2015, 230; KROMOTAROENO 2015, 82; WOLF 2019, 107; THURBER 2020, 1.

2 SEMENOV 1970, 191–193; MACGREGOR 1976; KÜCHELMANN – ZIDAROV 2005.

3 HERMAN 1887, 171–173; HERMAN 1898, 14–18; HERMAN 1902; CHOYKE 1996; CHOYKE 1999; BARTOSIEWICZ 2001, 306; CHOYKE – BARTOSIEWICZ 2005; BARTOSIEWICZ 2006, 180–183; DARÓCZI-SZABÓ 2010.

4 VÖRÖS 1996, 212; VÖRÖS 2009, 308.

Objects thought to be bone skates have also been discovered in Early Bronze Age sites. The pieces—which are considered the oldest examples—were found in the area of present-day Budapest in Hungary in a context associated with the Bell Beaker culture. Having been made of radii, they differ from the later periods in bone selection (as, later, metacarpi and metatarsi predominated).⁵ Objects interpreted as bone skates continue to appear in the archaeological record after the Bronze Age.⁶ This paper deals with medieval, early modern, and ethnographic examples.

Skating in written and visual sources

Early references to bone skates are known from both Northern runic literature and sources from the Eurasian steppe. The most prominent early source for the use of bone skates is William Fitzstephen's description of London, dating to the 12th century, in which he mentions skating on ice as a winter pastime in the chapter *De Ludis*. According to the description, when the marshes froze over, some people would tie animal bones under their feet and, using a peg stick, glide across the ice at high speed, sometimes playing a spear-thrust game.⁷

The term *Korcholyas/Korcholas* appears several times in Hungarian documents from the 14th century onwards, alongside personal names.⁸ Presumably, this referred to the profession of the person, but remains a question whether it really meant the modern term 'skate'. On the one hand, in Székelyföld,⁹ the hand sledge was also called *korcsolya*, but more importantly, both Ottó Herman and László Siklóssy mention that the tool used to lower the barrels into the cellar was called *korcsolya*. According to László Siklóssy, it was only from the 17th century onwards that the term 'skate' began to be used in its present sense.¹⁰ The possibility therefore arises that the term *Korcholyas/Korcholas* in the documents has more to do with this early meaning of 'skate'. That would make more sense because, as it is discussed in detail below, making a bone skate was not a particularly difficult task—even a 7–14-year-old child could do it—so there is no reason to believe that professionals made all (or any) pieces.¹¹



Fig. 1. Skating figures and a scene resembling spear-throwing in an illustration in Olaus Magnus' *Historia de Gentibus septentrionalibus* (OLAUS 1562, XI/29).

As for visual sources, we do not necessarily find skates made specifically out of bone, but skating is depicted in medieval scenes. The first known depiction of skating is found in a psalm book from the 1320s, at the month of February.¹² Küchelmann and Zidarov believe it to be the first known

5 CHOYKE – BARTOSIEWICZ 2005, 318, 320–321; KÜCHELMANN – ZIDAROV 2005, 430.

6 CHOYKE 1996; CHOYKE 1999, 151; CHOYKE – BARTOSIEWICZ 2005, 321, 325; BARTOSIEWICZ 2006, 180–181; DARÓCZI-SZABÓ – DARÓCZI-SZABÓ 2015, 229.

7 HERMAN 1902, 8, 10; STOW 1908, 218–229; MACGREGOR 1976, 61–62.

8 DF 248560; DL 14697; DF 229432.

9 A specific region in Transylvania where the Székelys live.

10 HERMAN 1914, 142; SIKLÓSSY 1927, 300.

11 S. KOVÁCS 1908.

12 *Psalter*. Bodleian Libraries, University of Oxford, 1320–1330, Bodleian Library MS. Douce 5, folio 1v.

representation of iron skates.¹³ Another early illustration, from 1498, is an image of Saint Lidvina falling on the ice, which left her bedridden for the rest of her life. This depiction shows several skating figures and a skate on Saint Lidvina's foot, even though it is probably not made of bone.¹⁴

From the early modern period onwards, illustrations proliferate, and skating appears in numerous paintings.¹⁵ First, two works by Olaus Magnus, the *Carta Marina de Descriptio septentrionalium terrarum* and the illustrations of the *Historia de Gentibus septentrionalibus*, are worth mentioning. These illustrations show people in the skating in the way as described by Fitzstephen in the 12th century. Of what their footwear is made is unclear, but they are gliding on the ice with the aid of a stick, and one illustration in the *Historia de Gentibus septentrionalibus* even shows a scene resembling a spear thrust (Fig. 1).¹⁶

Production and usage based on ethnographic sources

Ethnographic descriptions also show how skates were made and used. As it was mentioned, they are not very complicated to make, as the bones were extracted either from the dead animal or a carcass incinerator. The protruding parts at both ends of the bone were chopped off so that they would not get stuck and disturb the smooth movement on the icy surface later. In the case of horse bones, metapodia II and IV were removed. In some cases, the bone was pierced so it could be attached to the foot, and the nose of the skate was designed to be pointy. However, these steps were not always necessary. The holes, at either one or both ends of the bone, were perpendicular to the bone and parallel to the ice¹⁷ (Fig. 2). When the bone was not pierced but simply stood on, the friction between the bone and the footwear is greater than between the bone and the ice, and the weight of the skater prevented them from falling off the bone.¹⁸ There is no mention of the bones having been cooked or otherwise prepared. In fact, the original fat content of the bone was useful, as Olaus Magnus mentions.¹⁹ Moreover, ethnographic sources contain a skate variant which did not extend under the sole, but the heel of the boot prevented it from slipping out from under the foot.²⁰ It has been suggested that the flat surface of the bones was preformed, but there is no clear evidence for this practice.²¹

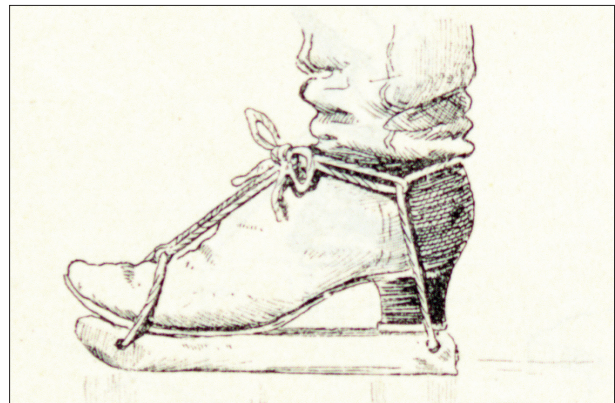


Fig. 2. Bone skate binding with *rámás* boots (after HERMAN 1902, 12, Fig. 4).

13 KÜCHELMANN – ZIDAROV 2005, 432.

14 Brugman, Johannes: *Vita alme virginis Lijdwine*. Utrecht, Museum Catharijneconvent, 1498, BMH i44, folio 12r; DIÓS 2002, 184.

15 Hieronymus Bosch: *The Garden of Earthly Delights*. Museo del Prado, Madrid, around 1500, triptichon, oil-on-panel; Pieter Bruegel the Elder: *Winter Landscape with Skaters and a Bird Trap*. Musées Royaux des Beaux-Arts, Brussels, 1565, oil-on-panel; Pieter Bruegel the Elder: *The Census at Bethlehem*. Musées Royaux des Beaux-Arts, Brussels, 1566, oil-on-panel.

16 OLAUS 1539; OLAUS 1562, XI/29, XX/17.

17 S. KOVÁCS 1908, 18; BARTOSIEWICZ 2006, 180.

18 HERMAN 1899, 268; GYÖRFFY 1934, 254.

19 CHOYKE 1999, 150; CHOYKE – BARTOSIEWICZ 2005, 322.

20 HERMAN 1887, 172; SCHÖNVISZKY 1932, 17.

21 KÜCHELMANN – ZIDAROV 2005, 433–434.

The act of skating may have been more difficult than one would think (especially compared to the making of the skates described earlier). The skaters placed a bone under each foot while standing on the ice in a relatively uncomfortable position, with their legs bent and slightly apart. Then, in a movement resembling skiing, but with a single stick put down at the front and in the middle, they pushed themselves forward. The skaters had to stand on the ice with parallel feet to not to fall upon pushing themselves forward with the stick (Fig. 3).²² In his description of the Netherlands, written in 1620, Márton Csombor Szepsi compares the more modern way of skating there (which was already resembling the skating we know today) with what he saw in the Kingdom of Hungary, where people propelled themselves with a stick.²³

Ironga or *korcsolya*? Names for bone skates

It is important to point out that, based on the ethnographic descriptions, the names for skates did not depend on design but region. The most frequent name is *ironga*, which was associated with the Great Hungarian Plain, as well as Bács and Borsod counties,²⁴ but also *gilics*, *glics*, which was the name of bone skates in the Saxon and Székely areas in Transylvania.²⁵ However, József S. Kovács mentioned at the turn of the 19th and 20th centuries that *gilics* was a more recent word. The older Székelys did not even use it for skates; its older name was *csáklya* instead. In addition, the name *teténke* can also be linked to the land of the Székelys.²⁶ The name variants are numerous: skates have been called *iringa* in Bács County, *korcsolya*, *korcsilya* in Szeged,²⁷ *korcsija* in Csongrád County,²⁸ *illanka* on Nógrád County, *csuszkondó*, *csicsonka*,²⁹ *csáklya*, *csákja*, *csákia* in Zilah, Csík, and Udvarhely counties, *csontcsáklya* in Kézdiszentlélek, *csuszka*, *csuszkora*, *siklyó*, *sikolya* in Csallóköz, and *slutyi* in Losonc.³⁰ The *sikolya* in the Csallóköz was sometimes made from horse jawbone.³¹ In the early 1900s in Transylvania, the larger bone skates were called *murza*, the smaller ones *csikó*.³² The *ironga*, which was earlier believed to refer to pieces without holes, might be in some regions an universal term for bone skates.

Like the instrument, the activity had various names in different areas, as did the stick used for skating. The activity has been called *irongálás* (Alföld), *iringálás* (Gömör County), *csáklyázás* (Csík



Fig. 3. Bone-skating child (after HERMAN 1902, 11, Fig. 1).

22 CZÉKUS 1893, 93; HERMAN 1899, 268; HERMAN 1902, 11–13; ECSEDI 1934, 265; BÁLINT 1957, 257; PALÁDI-KOVÁCS 1979, 638; GÉCZI 1984, 109; PETÉNYI 1994, 112; VAJDA 1996, 75; CSISZÁR 2009, 195.

23 KOVÁCS – KULCSÁR 1968, 189–190.

24 HERMAN 1887; HERMAN 1898; HERMAN 1899; HERMAN 1902; SEMAYER 1903, 200; TÖMÖRKÉNY 1906, 444; SCHÖNVISZKY 1932, 17; GYÖRFFY 1934, 254; PALÁDI-KOVÁCS 1979; KELEMEN 2001, 179; PALÁDI-KOVÁCS 2006, 96; WOLF 2019, 107.

25 S. KOVÁCS 1908; SCHÖNVISZKY 1932, 17; PETÉNYI 1994, 111.

26 S. KOVÁCS 1908, 20; GYÖRFFY 1934, 254.

27 BÁLINT 1977, 22.

28 TÖMÖRKÉNY 1906, 444.

29 GYÖRFFY 1934, 254; KOVÁCS – KULCSÁR 1968, 189.

30 CHERNEL 1893, 353; SCHÖNVISZKY 1932, 17.

31 CHERNEL 1893, 353.

32 S. KOVÁCS 1908, 20; SCHÖNVISZKY 1932, 17.

County), *csuszkorálás* (Csallóköz and Sopron County), *csüdözés* (Székelyföld), *illankázás* (Nógrád County), *sikonkázás* (Marosvásárhely), *sinkózás* (Borsod County), *slutyizás* (Vác and Losonc), *sikolyázás* (Csallóköz), *gilicsezés* (Saxons and Székelys in Transylvania),³³ *hiringálás*, *hilingálás*, *in-ingálás*,³⁴ *gusztonyozás*,³⁵ *szigonyozás*,³⁶ and *irontálás*,³⁷ while the names of the pointy stick include *gusztony*,³⁸ *szigony*,³⁹ *vonyogó*,⁴⁰ *gösztony*,⁴¹ *güsztony* or *gusztonyos bot*,⁴² *kusztony*,⁴³ *tolószigony*,⁴⁴ *iszánkodóbot*,⁴⁵ *csáklyás pálca*,⁴⁶ and *csáklyabot*.⁴⁷

Other potential uses based on the similarity of form

Sledge runners

In addition to skates, several theories have been raised on the function of the pieces recovered in excavations. One of these is sledge runners. It is somewhat problematic as sledges can also be dragged on ice, making it quite difficult to separate them from skates. The general view is that sledges have their holes perpendicular to the ice. The bones could be fastened to some kind of seat through the holes, and this way it could be used as a sledge. This solution is known from foreign ethnographic parallels.⁴⁸ Based on the writings of Ottó Herman, Károly Sági believed that the tool Herman called *lovasszánkó* (a sledge made with horse bones) may have been the precursor of the dogsled (*fakutya*).⁴⁹

Kececsont – fishing net sinkers

Another possible use of these bone objects is *kececsont* (*kece* bone). *Kuszakece* is a small fishing tool. The three nets of the *kuszakece* were tied to the two ends of the so-called *bónéfa* (an A-shaped wooden frame), which formed the basis of the tool. A longer, fine-mesh net (*léhés*) was tied between two coarse-mesh nets (*regina*). The end of the *bónéfa* was also connected to the net tendon, i.e. the frame rope of the net, to which the *kece* bones were attached. The bones, with pieces of lead (*turbukóloom*) between them, weighted down the net. The tension line of the *kuszakece* usually had 7 or 9 bones, with a radius in the middle, a metatarsal next to it in both sides, and then the other metacarpals. These were usually horse bones, as in the case of skates. *Kuszakece* was dragged along the bottom of the river in the mud to pull the fish out of it, usually in colder weather (Fig. 4).⁵⁰

33 SCHÖNVISZKY 1932, 17.

34 DÖMÖTÖR 1995, 345.

35 BÁLINT 1957, 237.

36 ECSEDI 1934, 265.

37 HERMAN 1914, 142.

38 SEMAYER 1903, 200; SCHÖNVISZKY 1932, 17; GYÖRFFY 1934, 254; BÁLINT 1957, 520; PALÁDI-KOVÁCS 1979, 638; BÁRKÁNYI 2001, 144.

39 ZOLTAI 1926, 16; ECSEDI 1934, 265.

40 HERMAN 1902, 10; SCHÖNVISZKY 1932, 17; GYÖRFFY 1934, 254.

41 GÉCZI 1984, 109.

42 BÁLINT 1957, 520.

43 ZOLTAI 1926, 16.

44 ECSEDI – SÖREGI 1932, 26.

45 HERMAN 1914, 142; SCHÖNVISZKY 1932, 17.

46 PALÁDI-KOVÁCS 1979, 638.

47 S. KOVÁCS 1908, 20; SCHÖNVISZKY 1932, 17.

48 HERMAN 1902, 20–27; CHOYKE 1999, 149.

49 SÁGI 1971, 347–348.

50 HERMAN 1887, 171–172; HERMAN 1898, 14, 16; HERMAN 1902, 29; S. N. 1969, 8; BÁLINT 1976, 434; FELFÖLDI 1993, 69; FERKOV 2006, 198; BÁRKÁNYI 2013, 17.

As the bones were dragged in the mud in the riverbed, all their sides became worn. Herman Otto mentions that the cross-section of the bones was polished to oval in prolonged use. Ends were the first to feature use-wear, and then the whole surface became worn, smooth, and slightly shiny. This may help identify such bones based on that, theoretically, most of their surface is worn, unlike those of skates.⁵¹

Smoothing tool

Bones finds with a flat surface on one side have been interpreted by many as textile or leather smoothers; however, conclusive evidence has yet to be presented. Observations of the Soviet researcher Sergei Semenov—published in his work entitled *Prehistoric Technology*—still hold up today, but his identification of some bones as smoothers is controversial. Of course, it cannot be ruled out that some pieces were (also) used as smoothers, but most finds probably had another function.⁵²

Perspectives of applying use-wear analysis

In light of the above, the aim of the current research was to determine which of the above-mentioned uses can actually be applied to the objects identified as bone skates in excavations, or possibly to establish which possibility can be excluded. A use-wear analysis was carried out to obtain this information.

The applied methodology built on the work of the aforementioned Sergei Aristarchovich Semenov, published in a study, *Первобытная техника (Опыт изучения древнейших орудий и изделий по следам работы)*, in 1957; it was published in English in 1964 under the title *Prehistoric Technology (an Experimental Study of the oldest Tools and Artefacts from traces of Manufacture and Wear)*.⁵³ According to the basic concept of use-wear analysis, if any material encounters any material during the work process, they will leave traces on each other. These traces are characteristic of, apply only to, the two materials in contact. However, these traces are influenced by the condition of the respective materials, the direction and length of contact, and the force applied. Thus, these traces—such as striation, abrasion, polish, microfracture, or splinter—can be used to deduce the materials in contact, the direction of the work, and the activity itself. Such an analysis might allow for estimating or identifying the way the tool was used.⁵⁴ While ethnographic analogies are important in identifying the observed traces, they cannot be applied unconditionally. The accepted method

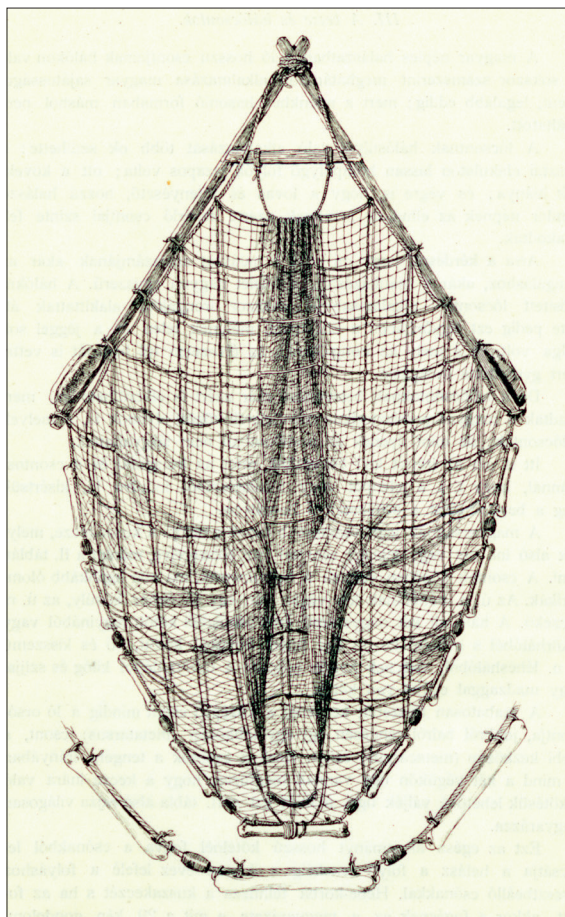


Fig. 4. Kuszakece and method of fastening of the kece bones (HERMAN 1902, 30, Pl. 2).

51 HERMAN 1887, 172.

52 TERGAST 1879, 43–44, Fig. 49; SEMENOV 1970, 192; based on MACGREGOR 1976, 57; KJELLBERG 1940; D. SZABÓ – CSIPPÁN 2006, 53.

53 SEMENOV 1970; LEMOINE 1994, 317; STONE 2011, 37–38; TÓTH 2013, 255.

54 LEMOINE 1994, 317–318; DARÓCZI-SZABÓ 2010, 40; TÓTH 2013, 255, 269; BRADFIELD 2015, 3.

for identifying traces is experimental, i.e. by producing traces that match those observed on the artefacts. Matching use-wear may serve as evidence of that the object could be used in the work process or movement.⁵⁵

In the low-magnification phase, at magnifications of 5–80× or up to 150×, the separation of taphonomic,⁵⁶ preparation, and use-related traces is carried out primarily using a stereomicroscope. In the high-magnification phase, at magnifications of 100×, 200×, or, where necessary, up to 500×, a more detailed examination of use-wear is undertaken.⁵⁷ In this research, the author employed zoom stereomicroscopes that formally fall within the low-magnification range,⁵⁸ but which nevertheless proved sufficient for the study and classification of these objects.

Analysis of bones from archaeological and ethnographic collections

A total of 29 bones were available for study, of which two jaw bones from the collection of the Museum of Ethnography were excluded. Thus, the analysed series consisted of 27 long bones, 22 of which could be examined microscopically. The group of bones examined under microscope was supplemented by one more experimental bone. Of the 27 bones, 15 originated from the Fishing Collection of the Museum of Ethnography's Collection of Farming, and 12 were medieval and early modern archaeological finds. They were found in various excavations, including one at Visegrád-Alsóvár, harbour (Inv. no. 1950.18),⁵⁹ four at Debrecen-Kölcsey Konferencia Központ (D1, D2, D3, D4),⁶⁰ six in Budapest: at 7–9 Várfoke Street in District 1 (Inv. no. 96.94.9), 2 Kígyó Street in District 5 (BTM5), 3 Szende Pál Street in District 5 (BTM6), Margitsziget [Margaret Island]-Dominican monastery in District 13 (BTM3), Várkert Bazár [Castle Garden Bazaar]-Öntőház Udvar in District 1 (BTM1), and an unknown site (BTM4). Yet another piece was found on the western side of the Szigetszentmiklós-Dunára dűlő site (BTM2) (Fig. 5).⁶¹

Based on microscopic observations, three factors became important for classification:

- Where and how strongly is the surface abraded and polished?
- Where can intense striations be found?
- What are the striations like?

An additional—the fourth—important factor was the design of the holes. Based on these characteristics, the analysed specimens could be classified into three categories (Tab. 1).

The first category (Type 1) includes bones with intense abrasion (effectively a flat facet) and polish on one side (dorsal or cranial). The other sides are also worn or shiny to some extent, but significantly less intensely. Striations are most prominent on the heavily worn surface that features lots of streaks. Predominant striations are long and narrow, running parallel to the longitudinal axis of the bone or at an acute angle (Figs 6–7).

55 REYNOLDS 1999, 388; KÜCHELMANN – ZIDAROV 2005, 425; OUTRAM 2008, 1; TÓTH 2013, 256.

56 TÓTH 2013, 27.

57 TÓTH 2010, 54–55; TÓTH 2013, 258–264; BRADFIELD 2015, 5.

58 The analysis was carried out in the Archaeometry Laboratory of the Institute of Archaeological Sciences of ELTE using a Zeiss STEREO Discovery V8 zoom stereomicroscope (specification: objective: Zeiss PlanApo S 1.00× FWD 81 mm; magnification range: continuous 10–80×; camera: Zeiss AxioCam MRc 5), as well as in the Budapest History Museum, Castle Museum, using a Nikon SMZ1000 zoom stereomicroscope (specification: objective: Nikon PlanApo 1.00× WD 70, Polaroid Circular PL 55 mm; magnification range: continuous 8–80×; camera: Nikon Coolpix P5100).

59 Hungarian National Museum, King Matthias Museum.

60 Déri Museum, Debrecen.

61 Budapest History Museum, Castle Museum.



Fig. 5. The examined bones (after SZATHMÁRI 2024, 67, Fig. 1).

Bones in the second category (Type 2) feature intense abrasion on at least three sides (dorsal/cranial, medial and lateral), following the curve of the bone, but not forming a flat surface on any. Striations are also intense on all three, sometimes all four, sides. Dominant striations run nearly parallel to the longitudinal axis of the bone or at an acute angle; they are long, but in some cases slightly curved, and, importantly, many also wider than the traces on the pieces in Group 1 (Figs 8–9).

The third category includes bones which do not fit the first two types.

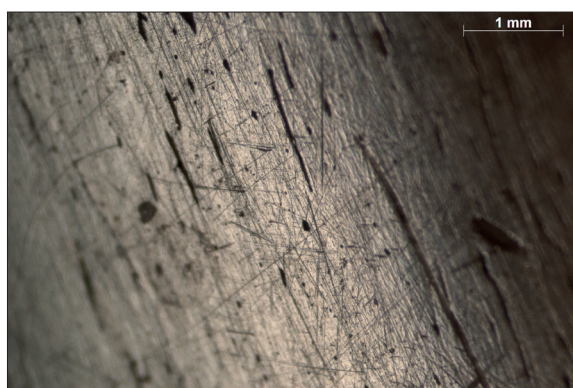


Fig. 6. Striations on the dorsal side of bone Inv. no. NM 31812. Dominant striations are nearly parallel to the longitudinal axis of the bone or diagonal, long and narrow (magnification 25×).

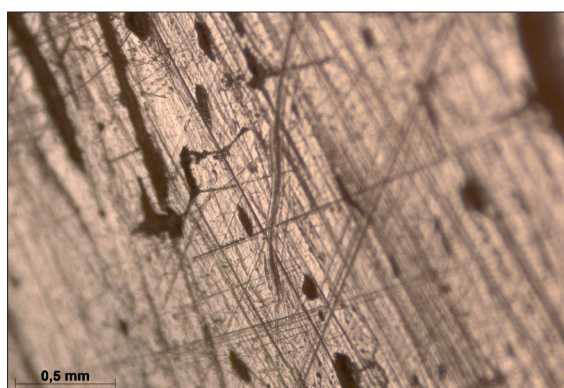


Fig. 7. Striations of the dorsal side of bone Inv. no. NM 135939. Dominant striations are nearly parallel to the longitudinal axis of the bone or diagonal, long and narrow (magnification 50×) (after SZATHMÁRI 2024, 83, Fig. 11).

Type 1 bones—with a flat surface and narrow grooves—could be identified as skates or sledge runners. This is where hole design became important: bones with holes perpendicular to the ice may have been sledge runners,⁶² while pieces with holes parallel to the ice (*medio-lateral*) or without any may have been skates. This group includes all bones inventoried as bone skates in the Museum of Ethnography, all examined bones from the collection of the Budapest History Museum, and two bones from Debrecen.⁶³

⁶² CHOYKE 1999, 149.

⁶³ SZATHMÁRI 2024, 80–82.

Tab. 1. First classification of the bones based on microscopic observations. Perpendicular: holes perpendicular to the longitudinal axis of the bone and perpendicular to the ice at both ends of the bone. Diagonal: from the direction of the epiphyses of the bone; the hole is diagonal to the palmar/plantar/caudal side of the bone. Medio-lateral: a hole perpendicular to the longitudinal axis of the bone and parallel to the ice at one or both ends of the bone.

direction of holes	Group 1				Group 2	Group 3		
	perpendicular	none	diagonal	medio-lateral	diagonal	perpendicular	diagonal	diagonal and medio-lateral
Inv. no. / ID	D3	BTM2	NM 5904	NM 42493a	NM 68.150.66	D1	NM 68.150.158	1950.18
	D4	BTM4		NM 42494b	NM 68.150.142	D2		
	BTM1	BTM5			NM 5903	96.94.9		
	BTM3	BTM6			NM 5905			
	NM 31812	NM 135939						

Type 2 bones feature intense signs of use-wear, including wider striations, over almost the entire surface. This category includes the *kece* bones from the Museum of Ethnography. The arrangement of the holes is fairly uniform: they are drilled diagonally from the articular end of the bones towards the posterior side, such that one end of each hole opens on the palmar, plantar, or possibly caudal surface.⁶⁴

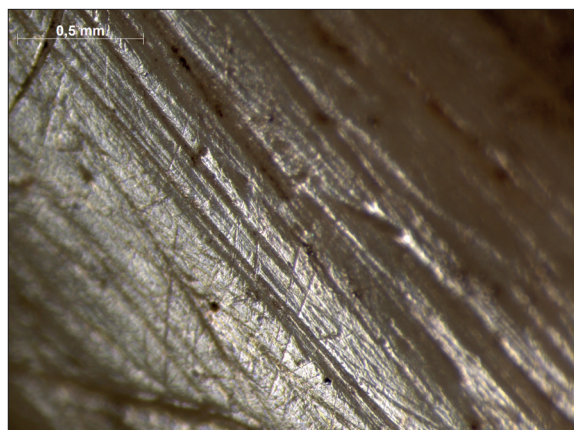


Fig. 8. Striations on the dorsal side of bone Inv. no. NM 68.150.66. Dominant striations are nearly parallel to the longitudinal axis of the bone or diagonal, long, with a significant part of them wider (magnification 63×).



Fig. 9. Striations and polishing on the medial side of bone Inv. no. NM 5905. Dominant striations are nearly parallel to the longitudinal axis of the bone or diagonal, long, a significant part of them wider (magnification 16×).

Initially, many bones were classified into the third category because of minor differences from Types 1 and 2. Eventually, two pieces remained here, D1 and D2. Although D1 may at first glance appear to be a sledge runner, its surface has been scraped and is dominated by small, short, narrow, perpendicular striations. The whole surface is exceedingly abraded, and it only features longer striations parallel to the bone's longitudinal axis towards the two ends (Fig. 10).⁶⁵

The other bone, D2, is also very interesting because it may have broken during the manufacturing process. The proximal end has a hole typical of a sledge runner bone, but the distal end is missing; the edge of a hole is visible but fragmentary. Nevertheless, the bone may have been used as an

⁶⁴ SZATHMÁRI 2024, 82.

⁶⁵ SZATHMÁRI 2024, 83.

ad hoc tool for an unknown purpose, as attested by some polishing and striation on and near the fracture surface.⁶⁶

As mentioned above, initially, three more bones were also included in this category. Bone 96.94.9 from András Végh's excavation at Várfok Street (District 1, Budapest)⁶⁷ was special because of the intense striations on the outer sides and the scraping of the bone. However, apart from these traces, its characteristics matched those of the first category, so eventually it was classified there, more precisely into the group of bones presumably used as sledge runners.

The observations made on a bone from the collection of the Museum of Ethnography (Inv. no. 68.150.158) are also interesting. It was listed in the inventory as a *kece* bone, but unlike the others, the predominant striations are perpendicular to the bone. These striations are wider but shorter due to their position (Fig. 11). Abrasion is visible on several sides, and the arrangement of the holes is consistent with that of a *kece* bone. This bone, however, is a radius, so it was probably fastened to the middle part of the tension line. The difference in the orientation of the striations can be explained by the odd number of bones in the net. Metacarpals and metatarsals can turn in the direction of pull, but the radius at the middle of the net must be perpendicular to that, which may explain the differences in orientation of the stripes observed on the bone. The flat facet on the cranial side of the bone is difficult to explain; it may be evidence of that the item had another function previously.⁶⁸

Bone 1950.18 was found at Visegrád in the Alsóvár, harbour/Parti Torony. It does not have a flat facet, several of its sides are heavily abraded, and its hole pattern is slightly different from the other pieces examined. It has fewer than usual wide grooves typical of the *kece* bones (Fig. 12) which, initially, prevented its classification into Type 2. It has a perpendicular hole typical of *kece* bones and a diagonal one typical of



Fig. 10. Striation perpendicular to the longitudinal axis of the bone at the junction of the plantar and medial sides of bone D1 (magnification 16×).

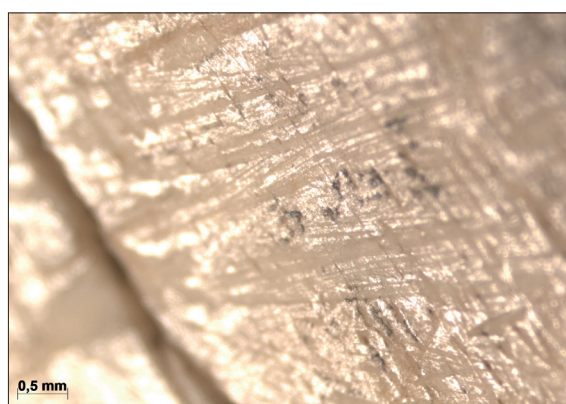


Fig. 11. Striation of the cranial side of bone NM 68.150.158 with wider striations perpendicular to the longitudinal axis of the bone (magnification 25×) (after SZATHMÁRI 2024, 85, Fig. 16).

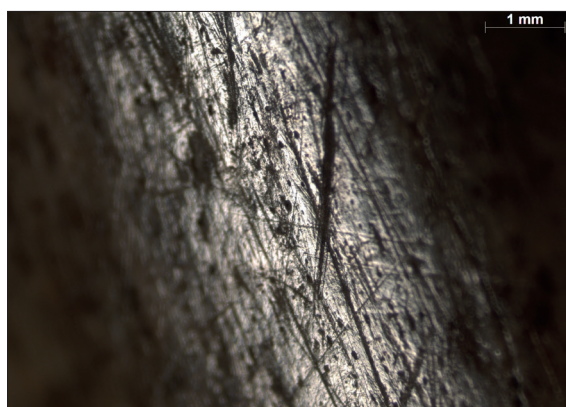


Fig. 12. Striation of the dorsal side of bone 1950.18 with long, partly wider striations nearly parallel to the longitudinal axis of the bone (magnification 20×) (after SZATHMÁRI 2024, 85, Fig. 17).

66 SZATHMÁRI 2024, 87.

67 VÉGH 1999, 343–345.

68 SZATHMÁRI 2024, 84–86.

skates. Nevertheless, it is likely a *kece* bone, and the difference in the wideness of the striations may be due to the different silt composition of the Danube and the Tisza. Alternatively, it could be a tool for a different fishing method. Proving that, however, requires further research.⁶⁹

Bone 5904 from the collection of the Museum of Ethnography features use-wear that clearly indicate that it was used as a skate (Fig. 13). However, the holes are identical to those in *kece* bones, and the item was listed in the inventory book as a *kece* bone. This bone is an excellent example of how these tools could have been used for several different things, acquiring new functions (Tab. 2).⁷⁰

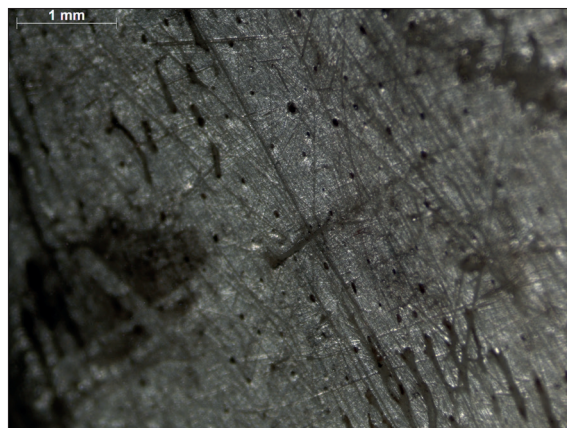


Fig. 13. Striation of the dorsal side of bone Inv. no. NM 5904, with dominant narrow, long, diagonal lines and additional broader and perpendicular lines (magnification 25×) (after SZATHMÁRI 2024, 85, Fig. 15).

Tab. 2. Classification of bones by function.

direction of holes	Skate or sled				Kece bone		Other function
	perpendicular	none	diagonal	medio-lateral	diagonal	diagonal and crosswise	perpendicular
Inv. no. / ID	D3	BTM2	NM 5904	NM 42493a	NM 68.150.66	NM 68.150.142	D1
	D4	BTM4		NM 42494b	NM 5903	1950.18	D2
	BTM1	BTM5			NM 5905		
	BTM3	BTM6			NM 68.150.158		
	NM 31812	NM 135939					
	96.94.9						

Experimental archaeology

The use-wear on the bones enabled their classification. However, to test that the pieces in the first group could have been used for skating, experimental archaeological methods were applied.⁷¹ Experimental archaeology and use-wear analysis go hand in hand, since one of the main factors in use-wear analysis is comparability. Today, the accepted method in use-wear analysis is to compare observations with pieces in reference collections. Work processes are reconstructed using ethnographic parallels. The only result deemed satisfactory is if the traces, generated during the experiment, match those observed on the archaeological artefacts.⁷²

The main question in the present experiment was if the assumed ‘bone skates’ (with a flat surface) found in archaeological contexts were actually used for gliding on ice, and can therefore be considered to be skates.⁷³ Additional questions also arose: How long does it take for the characteristic flat surface to appear? What is the order of development of the abrasion and polish? Can they even

⁶⁹ SZATHMÁRI 2024, 86–87.

⁷⁰ SZATHMÁRI 2024, 84.

⁷¹ Experimental archaeology is considered a scientific tool; when it is applied, the researcher is conducting a scientific experiment. The process must therefore meet the requirements of a scientific experiment, which include reproductibility and suitable documentation (TÓTH 2013, 255–256).

⁷² TÓTH 2013, 255–256.

⁷³ SZATHMÁRI 2024, 78–79.

be separated? When does abrasion start to appear? How long does it take for secondary polish and rounding to develop on the foot side?

It is important to consider first if a question can be answered by a single experiment or a series of those. Series of experiments must be sequential—changing only one thing at the time—in order to keep track of exactly what has influenced the result.⁷⁴ Lack of resources prevented the realisation of series of experiments; the single available bone enabled only a single one.

The next step is to design and prepare the experiment. This phase involves selecting materials and contact materials and planning the movement. Materials are chosen based on the species and skeletal part represented by the examined artefact in the archaeological record. The choice of contact material is based on presumed function; importantly, only materials appropriate to the period shall be used in the experiment. In addition to archaeological information, it is worth examining ethnographic parallels to reconstruct the movement—but not borrowing anything unconditionally as the goal is to reconstruct movements from hundreds or even thousands of years ago. In the case of medieval artefacts, such parallels compared with written and visual data may prove more important in the process.⁷⁵

Several problems arose while designing the experiment, starting with the procurement of raw material. Historical skates were made of metacarpal or metatarsal bones, which are currently unavailable at butchers due to changes in purchasing and consumption habits. All products from slaughterhouses require a Health and Consumer Protection Agency license, so it was not possible to obtain bones from there either. Cattle slaughter in the countryside is quite rare nowadays. On the basis of the archaeological record, the radius can also be considered in addition to the metapodium bones. Horse bone was the most commonly used raw material, but the chance of obtaining it, whether metapodium or radius, is closer to zero.

Although an ideal taxon of the right species could not be obtained, it was possible to study how the bone glides on ice. For this experiment, I used a left radius of a juvenile red deer (*Cervus elaphus* L. 1758).⁷⁶ The radius is perhaps the rarest raw material of skates, which does not appear amongst ethnographic parallels. It was far from widespread in the Carpathian Basin; a skate made of a deer radius is known from 12th-century Germany.⁷⁷

The obtained bone was less than ideal from the experiment's point of view—especially because it had been boiled—however, it was suitable for observing traces, and that was the main goal. The availability of a single bone excluded testing ethnographic parallels and reconstructing skating methods using medieval written and pictorial sources.

The problems arising in the preparation phase included the material of the skate, of the contact surface (ice), and the footwear. In historical times, skating was only possible on frozen natural waters; thus, the ideal contact surface would have been a frozen lake. Ice skating rinks were considered, but the modern skates cut into the surface of the ice, making it grooved, unlike natural conditions. As that could have affected the results significantly, the possibility of using artificial ice rinks was rejected—based partially on observations by Küchelmann and Zidarov, who first tried their experimental bone skates on a hockey rink, but found that the ice there was very different from natural ice. Therefore, they repeated the experiment during winter on natural ice, and found it easier to skate there.⁷⁸

74 OUTRAM 2008, 1–4; TÓTH 2010, 50.

75 OUTRAM 2008, 4; TÓTH 2010, 50–51; TÓTH 2013, 267.

76 I would like to take this opportunity to thank András Kovács, who provided the bone used in the experiment, for making it possible to carry it out.

77 KÜCHELMANN – ZIDAROV 2005, 433.

78 KÜCHELMANN – ZIDAROV 2005, 436.

Given the problems regarding the bone, the experiment could only be conducted on ‘artificial’ ice: on water frozen in a tray.⁷⁹ However, that was virtually sterile, containing no natural contaminants present in lake or river ice; nonetheless, it provided suitable conditions for observing the effect of ice on bone.

The third problem was the lack of leather-soled shoes; the experiment was executed using boots with common plastic soles. As the experiment focused on studying the ice side surface of the bone, this was considered a minor problem. Of course, the shoe-side of the bone was also documented in each phase of the test, but it is important to note that these traces cannot be considered fully authentic. Further experiments are necessary to describe the formation of foot-side polishing.

Conclusively, the experiment had to be tailored to the circumstances. The raw material was a deer radius in contact with ice frozen in a tray. The movement would ideally have been a continuous one-way slide, but the small size of the tray made this impossible, so it was only possible to move the bone back and forth. It was necessary to make many compromises in order to carry out the experiment, but the author believes that the experiment was sufficient to obtain a credible answer to the primary research questions.

After designing the experiment, the next step is to carry it out (Fig. 14). The preparation, design, and execution of the experiment require accurate documentation. The experiment started with the documentation (microscopic observation) of all instruments and materials involved. As only one bone was available, the experiment was performed in stages. The experiment involved seven 15-minute skating sessions, each concluding with the documentation of all observations and the traces⁸⁰ on the bone using a Zoom SteREO microscope.⁸¹



Fig. 14. The experiment in progress (photo by Laura Rácz).

The experiment did not go smoothly. The ice broke during all skating sessions, in one case flowing out of the tray at the very beginning of the experiment, likely because it was too thin and the tension in the tray was too high. On three other occasions, the experiment had to be ended too soon for similar reasons—these experiences can be considered to represent an important lesson for the future. Three 15-minute sessions could be completed but the ice became quite fragmented by the end in each case, and the experiment had to be paused several times to replace the ice pieces that had fallen out. In addition, the ice usually melted heavily, and the bone became very wet each time.

After the experiment has been completed, the next stage involves evaluation and analysis of the results—followed ideally by publication.⁸² The questions asked were partially answered after the first skating session, as a scratched surface started to form on the ice side of the bone, where the top layer of the bone surface peeled off in a patch (Fig. 15). This was not an obviously flat facet then a patch, maybe the first stage of formation of one. Abrasion and polishing also appeared, but it was difficult to distinguish between the times of their formation as both were present after the first

79 By the time the bone became available, the weather was not cold enough for waters to freeze naturally.

80 OLLÉ – VERGÈS 2014, 61; BOREL *et al.* 2019, 86.

81 Zeiss SteREO Discovery. V8 zoom stereomicroscope, Specification: objective: Zeiss PlanApo S 1.00× FWD 81 mm; magnification range: continuous 10–80×; camera: Zeiss AxioCam MRc 5.

82 TÓTH 2010, 54.

session. More intense wear and polish were also present on the foot side, proving that ‘foot shine’ started to develop early. Nevertheless, it is important to stress that this is a result of an experiment made with a plastic sole, which limits its reliability, as other materials, such as leather might have led to totally different result in intensity. A few scratches appeared on the ice side but not the expected striation.

The second session was unsuccessful, but after that, the same trends were observed during the third and fourth ones. The abraded surface increased, a continuous shiny surface developed in the middle, and the protrusions at the ends of the bone flattened and abraded. By then, shiny patches had already appeared outside the abrasion. There was also an increase in the size of the worn, shiny surface on the foot side. During the third session, the bone left a mark on the ice: a gouge formed as the bone was pushed and pulled.

Session five can perhaps be considered the dividing line, as after that, long, narrow line bundles nearly parallel to the longitudinal axis of the bone, formed on the abraded surface. A more pronounced polishing appeared along the abraded patch (Fig. 16). The abrasion on the ice side at both ends of the bone also became more pronounced. By the end of session 6, the abrasion was nearly 7 cm long. A new, smaller abraded patch developed between the proximal end of the bone and the already abraded surface. In addition, more and more of the ice side of the bone became worn and shiny, and the wear and shine became even more intense at the ends of the bone. The long, parallel striations became completed with short striations perpendicular to the bone.

The last, seventh session lasted only 7.5 minutes, as the ice became destroyed. At the end of the experiment, striations could be observed not only in the centre of the abraded area on the ice side but also around it and on the protruding surfaces. Wear and polishing became generally more pronounced and extensive, appearing on both sides of the abraded patch. Striations were clear to discern in its centre, dominated by long narrow lines nearly parallel to the longitudinal axis of the bone (Figs 17–18).

The research questions could be only partially answered. The seven skating sessions, of a total length of 1 hour and 13 minutes, were not enough for a flat facet to form, although several layers of the bone surface wore off in an extensive area and a new, small, abraded surface started to form at the proximal end of the diaphysis (Fig. 17). Despite this, the ice side of the bone remained curved. This suggests that a flat surface would have appeared only after hours, possibly days, of use.

During the first session the polishing and abrasion could not be separated—after fifteen minutes, they appeared together. In the case of later sessions on the abraded area, it was observable that the abrasion formed first, the polish appeared later, at first incoherently, then became coherent over time. The freshly abraded surface thus had a rough interface, but the remaining, higher layers at the edge of the abraded patch showed a stronger polish.

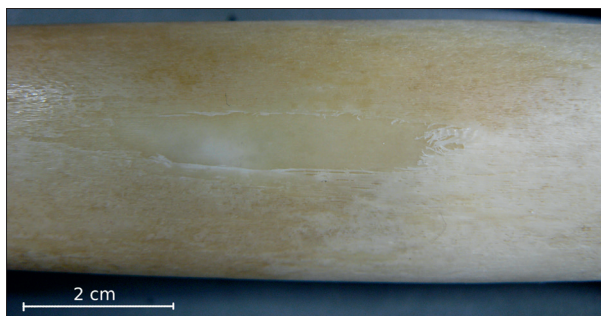


Fig. 15. The abraded area on the cranial side after Session 1.

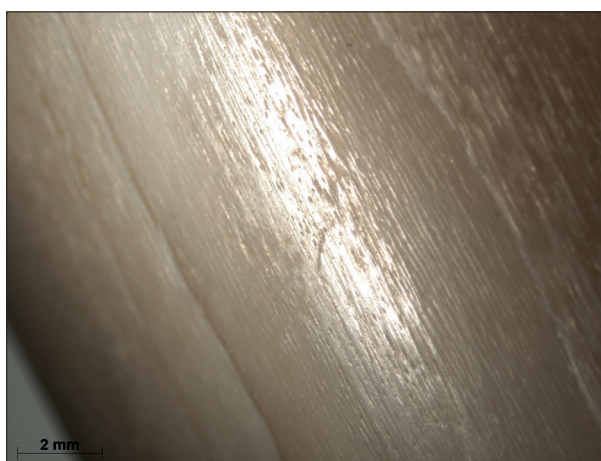


Fig. 16. Polishing in the middle of the abraded surface after Session 5 (magnification 10×).

The time of appearance of striations could be identified more precisely. After 15 minutes, 1–2 scattered scratches could be observed, then more and more with each session. True skating-related grooves started to develop during the sixth and seventh sessions, i.e. 50–65 minutes (Fig. 18).

Secondary polishing and rounding—‘foot shine’—started to develop quickly. After 15 minutes, intense wear and polish developed on the foot side. In the following periods, the worn, shiny surface became more and more extensive. However, this result is probably influenced by the plastic soles (instead of leather) used in the experiment.

Summary

The most important question is whether the objects identified as bone skates can be really skates. A long, narrow striation, nearly parallel to the longitudinal axis of the bone, appeared on the bone used in the experiment. Such use-wear was also observed on the dorsal surfaces of ethnographic parallels and the pieces classified as Type 1. The striation was also intense on the ice side of the bone. A flat surface did not appear, but the abraded area may be an initial phase of one: several bones featured a flat—in the case of metacarpals and metatarsals, slightly hourglass-like—surface that did not yet extend over the entire ice side. This may also imply that the ice side of the bones was not pre-flattened, but, as in the experiment, the dorsal side of an unformed bone became flattened by ice in prolonged use. These results support the theory that bones with such use-wear may have been skates.

However, it is important to stress that not all ‘skates’ are what they seem. Although most examined bones could have been used for skating and gliding on ice, the results suggest that some were certainly not. Those pieces with a flat surface (even if only in an initial form) and intense, narrow, long striation parallel to the longitudinal axis of the bone may indeed have been skates or possibly sledge runners, depending on the arrangement of holes.

Others are *kece* bones, also known from ethnographic collections. These have several heavily worn sides, broader striations, and usually a hole arrangement different from skates. Such bones in the Middle Ages and later centuries were used as net weights.

Moreover, according to the traces are some very interesting pieces could be neither skates nor net weights. Determining their function would require special studies and experiments, as would a more detailed study of the *kece* bones.



Fig. 17. The abraded area after Session 7 (1 hour 13 minutes of use).

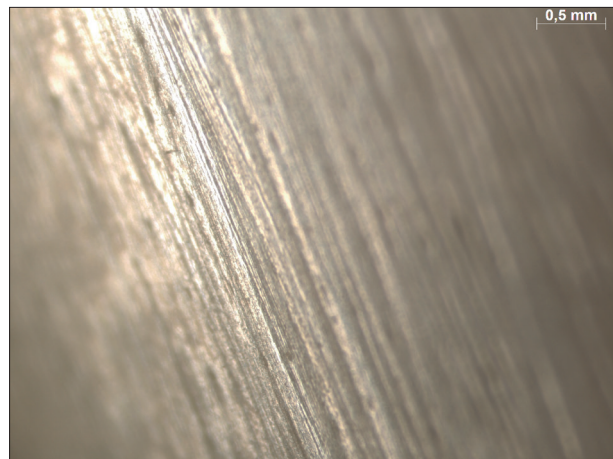


Fig. 18. Clear, long, narrow striations in the abraded area, almost parallel to the longitudinal axis of the bone, after Session 7 (magnification 32×) (after SZATHMÁRI 2024, 83, Fig. 10).

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