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Reviewed Article:

A Singing Bone from the Mätäjärvi ('Rotten Lake') Quarter of Medieval Turku, Finland: Experimental Reconstructions and Contemporary Musical Exploration

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Author(s): Riitta Rainio [1] ✉, Annemies Tamboer [2], Taina Saarikivi [3]

[1] University of Helsinki, Department of Cultures, Fabianinkatu 24 Room 132, 00014 Helsinki, Finland.

[2] Independent researcher, the Netherlands.

[3] Independent researcher, Finland.

At the turn of the 14th and 15th centuries, in the town of Turku (SW Finland), a new quarter was built near a lake that came to be known as Mätäjärvi ('Rotten Lake'), possibly because it was polluted by the waste from leather tanners, shoemakers, and other artisans. In the excavated remains of a wooden house in this quarter, objects like leather shoes, clippings and scrapings, imported stoneware from Germany, bone beads, spindles, and numerous bones of young cats, dogs, sheep, pigs and cattle were found, allowing the conclusion this might have been an artisan's dwelling. On the premises, a part of a worked sheep shin bone was found that we have interpreted as a flute of the block-and-duct type with two or three finger holes. This is a rare find for Finland, where, contrary to other parts of Europe, only a very small number of bone wind instruments are known, all dating from the late Middle Ages and nearly all found in Turku. This flute was a coarsely made simple instrument with a small ambitus. In many regions, flutes were traditionally played by shepherds as a means to communicate with their flock and as entertainment while herding. As we know that sheep and other domestic animals were kept in Turku, it is tempting to interpret the flute as a shepherd's instrument, but sources pertaining to the use of this particular artefact are lacking. We made two hypothetical reconstructions of the flute from similarly shaped and sized unprovenanced medieval sheep shin bones, one with two finger holes and the other with three finger holes. Flutist and sound artist Taina Saarikivi then explored the musical possibilities of the three-holed reconstruction by experimenting with it for over a year, making this medieval instrument sound or sing again.

> Although this particular find is fragmentary and far from being a showpiece item, it provides some snapshots of flute making and playing on the fringes of Europe in the 14th–15th centuries.

Introduction

Medieval bone flutes are undoubtedly the musical instruments or sound instruments most frequently encountered in European archaeological contexts. Literally, hundreds of bone flutes dating from the 9th to the 16th centuries have been found in Central and Northern Europe, primarily in Great Britain, the Netherlands, Germany, Denmark, Sweden, Poland, and the Baltic countries (e.g., Megaw, 1960; 1961; Crane, 1972; Brade, 1975; Lund, 1981; 1985; Moeck, 1996; Poplawska, 1998; Tamboer, 1999; 2004; Leaf, 2006; 2008; Oras, 2015; Montagu, 2017). The majority of these instruments have been made from sheep shin bones or bird wing bones by providing the bone tube with a sound hole and two to five finger holes. From an organological point of view, these instruments rank among block-and-duct flutes, that is, relatives of later penny whistles and recorders. In spite of the prevalence and obvious importance of these flutes, very little is known about the sounds and music that was played with them. Their makers, players, and contexts of use remain largely unknown.

In most cases, archaeological find contexts yield only general information about the cultural setting, e.g., whether the artefact comes from an urban or a rural environment, a dwelling, a castle or an ecclesiastical building (see Brade, 1975; Leaf, 2008, pp.236–457). Medieval music treatises do not mention bone flutes at all, and manuscript illustrations and other iconographic sources appear to depict mainly wooden flutes or other types of wind instruments, such as trumpets, horns, shawms (Leaf, 2008, pp.20–30). The reason for this dismissal might be related to the status of the bone flutes, being considered as somehow commonplace or plain, too trivial to be treated in written and pictorial records. A somewhat similar marginalization appears to occur in the present-day research literature that lacks updated overviews, and comparative analyzes of the European bone flute finds, let alone studies of the musical tradition related to them. Moreover, exact copies of the finds are rare because the bones of modern sheep breeds are far too big for raw material.

This article reports an experimental archaeo-musicological research project, in which a medieval bone flute from Turku, SW Finland, was examined, reconstructed and then sounded to bring together all available information on this particular find. The bone flute under consideration (See Figure 1) is only a fragment and more rough-hewn than many Central European finds. Still, it is one of the few examples of archaeological wind instruments in Finland, where soil conditions are exceptionally unfavourable for the preservation of bone. The number of probable wind instruments excavated in mainland Finland is only six at the moment (Rainio and Tamboer, 2017; Tamboer and Rainio, 2020). All of them come from the medieval town of Turku. At the first stage of our project, the chosen bone flute with an inventory number TMM 21816: LU54 was documented, measured, photographed, drawn and observed under the microscope at the Museum Centre of Turku. During the same visit, music archaeologist Riitta Rainio also scrutinized other artefacts from the same find context, as well as the find database and the excavation report of the related Åbo Akademi site excavated extensively in 1998 (Find database; Pukkila *et al.,* 2000; Rainio, 2013). At the next stage, music archaeologist and instrument maker Annemies Tamboer produced hypothetical reconstructions of the find, using as raw material unworked, unprovenanced medieval sheep shin bones that appeared to have about the same dimensions as the Turku find. Thus, the reconstructions became plausible representatives of typical medieval bone flutes. At the last stage, one of the reconstructions was handed over to professional flutist and sound artist Taina Saarikivi, who played the flute for over a year, to get to know it thoroughly. The purpose of this practical archaeo-musicological experiment was to acquire experiential and embodied information about the musical, technical, and sensorial characteristics of medieval bone flutes, essentials that defined and possibly discerned them from other, later types of flutes, e.g., western concert flutes. Using this set of methods, we hoped that the fragmentary flute from Finland could add something new to the knowledge of medieval bone flutes, as well as promote them to contemporary music-making, that is, making them sing again.

Find Context of the Mätäjärvi Flute

Turku is a medieval town and the former capital of Finland located by the Baltic Sea. It was founded at the turn of the 13th and 14th centuries at the instigation of the Swedish Crown, the Catholic Church, and the Dominican Order to organize and regularize administrative, ecclesiastical, and commercial life in the eastern part of the Swedish Kingdom (Hiekkanen, 2003). During the 14th century, the majority of burghers, merchants, and artisans were immigrants from Germany, mainly from the areas of Lübeck, Rheinland, and Westphalia (Kallioinen, 2000, pp.40–44, pp.103–109). Town dwellers also included civil and military servants from Sweden, Latin-speaking clergymen and Finnish people from the surrounding countryside. In the course of the 15th and 16th centuries, the number of Finnish and Swedish burghers grew substantially (Kallioinen, 2000, pp.137–140, pp.289–305). Under these circumstances, it seems evident that the musical life in medieval Turku was multicultural and multifaceted in character.

The bone flute under discussion was found in the so-called Quarter of Mätäjärvi ('Rotten Lake'), a neighbourhood that grew on the outskirts of Turku at the end of the 14th century (See Figure 2) (Pihlman, 2010; Seppänen, 2012, pp.944–947). On the basis of extensive urban excavations and associated research projects, this quarter was inhabited by artisans, first and foremost by leather tanners, skinners, furriers, and shoemakers (Tourunen, 2008, pp.125–132; Seppänen, 2012, pp.835–837, p.863). The inhabitants dumped their waste pieces, horn cores, slaughtering offals and food remains in the nearby swampy lake that came to be known as Mätäjärvi, probably because it was polluted by the waste (Lempiäinen, 1985; Pihlman *et al.,* 1985; Vuorela, 1985; Vuorisalo and Virtanen, 1985).

The bone flute was found in a block consisting of several wooden, dendro-chronologically and stratigraphically dated buildings: a dwelling house RA 186 with two rooms (AD 1380–1429), a courtyard with wooden pavement (AD 1400–1450), a probable shelter for domestic animals (AD 1400–1450), and a tanner's or shoemaker's workshop with large barrels, water channels, and traces of a drying rack (AD 1400–1450) (See Figure 3) (Seppänen, 2012, pp.307–310, pp.328–330, pp.336–337, pp.354–356, pp.362–365, pp.377–383, pp.406–417, pp.840–845, Appx 1). The open filling layer M 147, in which the flute was found, was mainly associated with the north-western room of the dwelling house RA 186, but part of it stretched onto the pavement outside the house (Seppänen, 2012, p.362, pp.413–414). The layer, as well as the flute, can be dated from the end of the 14th century to the beginning or the first half of the 15th century (see Seppänen, 2012, Appx 3). The layer contained late 14th and 15th-century stoneware from Langerwehe, Siegburg, Waldenburg and Lower Saxony, a large number of leather shoes, fragments of shoes, leather clippings, scrapings and waste pieces, and numerous bones of cattle, sheep, goat, pig, squirrel, dog and cat, many of them deriving from young animals, which points to the direction of skinning, fur processing or other craft activities (Find database; Tourunen, 2008, pp.51–54, pp.75–80, pp.108–109, pp.143–144, Tab. 9, Appx 4; Seppänen, 2012, p.362, pp.413–414). Furthermore, the layer contained pieces of textile, wooden staves, iron nails, bone and amber beads, a bone stylus, thimble and spindles,

whetstones and other artefacts, more or less typical of medieval households (Find database; Seppänen, 2012, p.362, pp.413–414). As the layer was recovered as one entity and sieved afterwards, the exact locations of these finds are unknown, with a few exceptions. A cut tip of elk antler was recovered between a floorboard and a wall timber in the north-western room of the dwelling house RA 186 (Find database), and a beater of a Sámi shaman drum, made of reindeer antler, was recovered under the floor of the same room, where it appears to have been hidden on purpose (Pukkila *et al.,* 2000, p.62; Hukantaival, 2006, pp.91–92; 2016, p.83, Appx 3: p.24; Seppänen, 2012, pp.413–417; Rainio, 2013). A similar concealment of another extraordinary artefact, a wooden anthropo-zoomorphic staff under the floor of the south-eastern room of the dwelling house RA 186 raises questions about the beliefs and religious activities of the householders (Pukkila *et al.,* 2000, p.63; Seppänen, 2012, pp.413–417). As a whole, this find material suggests connections to wide geographical areas: from Germany to the indigenous Sámi areas in northern Fennoscandia, and perhaps to the city of Novgorod, where the closest parallels to the anthropo-zoomorphic staff have been excavated (Kolchin, 1989, pp.191–196, Pl. pp.200–208; Pokrovskaya, 2007).

A Sheep Shin Bone Turned into a Flute

The worked bone TMM 21816: LU54 from the Quarter of Mätäjärvi is a part of a shin bone or tibia, the lower part of the hind leg of a sheep or a goat. The longitudinal curve of the tube indicates that the bone originated from the left hind leg of the animal. The flat side, provided with carved holes, was the backside of the leg, whereas the opposite side with a ridge was the front side. Sheep in the Middle Ages were different from the sturdy breeds prevailing nowadays, and their skeleton bones were very similar in shape and dimensions to those of contemporary goats. Hence it is difficult to determine whether a sheep or a goat provided this particular bone. Of sheep, we know for sure that these were kept in Turku in the period the tibia is dated. Goats were kept too, but obviously to a lesser extent (Tourunen, 2008, pp.40–42, pp.96–104, pp.140–141). For convenience, we use here the designation “sheep bone.”

A sheep tibia is pre-eminently suited to turn into a block-and-duct duct flute because its upper end is widening. When the ends of the bone are opened up, and the marrow is removed, possibly by cooking in a broth, a tube with a wide, conical end will result. In the Mätäjärvi bone, the outer diameter of this wide end is 19 x 20 mm, while the inner diameter is 15 x 16 mm (See Figure 4a). The conical cavity at the wide end influences the displacement of air when the tube is blown: blowing the wider end produces a sound that is lower than in a cylindrical tube of the same length and cavity volume. In addition, the conicity gives way to the flute’s mouthpiece constructions: the block and windway. For making another type of wind instrument, such as reed pipe, other types of bone are better suited. An example of this is a sheep metatarsus excavated in Turku with a more or less cylindrical narrow bore that we reconstructed with a vegetable reed (Rainio and Tamboer, 2017; Tamboer and Rainio, 2020). The upper end of a sheep tibia is too wide to accommodate a reed. If desired, a reed can be

inserted in the lower narrow end that in the Mätäjärvi bone measures 9 x 10 mm (outer diameter) or 4 x 5 mm (inner diameter) (See Figure 4b). However, the interpretation of the Mätäjärvi artefact as a reed pipe seems implausible. If the wide end of this bone was meant to be the bell – the flared outer end – of a reed pipe, it would have been cut across at a straight angle, not at an oblique angle. An oblique, slanting beak is typical for many, if not all, mouthpieces of bone duct flutes. Its purpose is to facilitate blowing. Therefore, this feature typifies the Mätäjärvi artefact as a duct flute.

In its present state, the Mätäjärvi sheep tibia is 89 mm long. Though bone flutes about that short do occur (e.g., Tamboer, 2004; see Figures 1–5a), this was obviously not the intended length of this artefact because the lower narrow end is clearly broken off. The lower end is broken across a human-made hole next to a deep, transverse cut (See Figure 5a). To the eye, the bone here seems to be much thicker compared to the upper wider end of the bone, but the difference is negligible: 2.5 mm at the break, 2 mm at the top end. In the upper wider end, a small part of the front side is broken away. The wall of a tibia bone is thinner here and has a spongy inside structure that is more vulnerable and prone to damage than the more massive parts. The gently curved, slanting rims of the beak are not broken off but have been cut with a knife (See Figure 5b).

The flat backside of the Mätäjärvi tibia has been turned into the front side of the flute by adding holes. Two human-made holes are clearly visible (See Figure 6); of a third hole, only the top rim is left. As the lower part of the tube is lacking, we do not know whether the artefact was originally provided with a fourth hole. The diameter of the more or less round holes is 4 x 4 and 4 x 3.5 mm. Transverse scratches around the two holes and the deep cut at the damaged hole make clear how the maker proceeded in perforating. At first, the maker thinned the places of the intended holes by cutting, or rather chopping them with a knife. This makes it easier to drill a hole through the thick wall of the bone. Furthermore, the resulting concave surfaces make it easier for the fingers to find and close off the holes when playing. This is a feature found in several medieval bone flutes (Leaf, 2008). Drilling of the holes in the Mätäjärvi tibia was probably executed by scraping with a knife and by turning the point of the knife round and round. This can be deduced from the fact that the holes are not quite as circular as when executed by a drill. The ridges around the holes were not finished off. Perhaps the strategy was to scrape off all cutting traces in the end if the instrument appeared to play satisfactorily. Was the maker of the Mätäjärvi flute dissatisfied with the result, leaving the rims of the holes unfinished or discarding the artefact after it broke? Or was the maker just sloppy? All in all, this flute is rough-hewn and coarsely made compared to other bone flutes of the same type, excavated in Great Britain, the Netherlands, or elsewhere in Central Europe (See Figure 7).

In duct flutes, the windway directing the airflow against the rim of the soundhole – the window – is usually shaped by inserting a separate block to the blowing end. However, duct

flutes in which the player's tongue acts as a block are known too (Emsheimer, 1981; Lund, 1981). In these so-called tongue duct flutes, the window is placed fairly close to the end of the bone because the player's tongue tip acting as a block has a limited length. The wall on the opposite side of the window is usually removed to give way to the lower lip of the player. This is not the case in the Mätäjärvi flute. In this artefact, the distance between the window and the blowing end is too large to enable the playing as a tongue or lip duct flute. That is why the interpretation as a block-and-duct flute is more plausible in our conclusions. A block can be cut from wood, as is the case in medieval and later wooden recorders. Some wooden blocks and even an example of a bone block have been found inside medieval bone flutes, but these finds are rare (See Figure 7; Lund, 1985, pp.14–15).

On the other hand, beeswax is a material that can easily be made to fit in the irregularly shaped bores and the rough inside walls of the bone tubes. This material will decay quickly in the ground and will not be found. As the blocks are missing in the majority of the medieval bone flute finds, it is a guess what materials were originally applied. The same holds for the shape of the blocks. The wooden blocks found inside a few bone flutes have been shrunken and distorted by their stay in the ground. Their original shape, especially the shaping of the top surface that functioned as the lower level of the windway, cannot be made out in detail. The shape of the block determines the lower part of the windway, the way the blown air is being compressed and directed to the lip in the window, and hence the possibilities for producing notes and the sound character. As no block or traces of block material have been found in the Mätäjärvi flute, the shape and bevel of its beak and the window rim are the only clues we have for reconstructing the block.

We interpret the carved hole near the wide end of the Mätäjärvi flute as the window. The hole is not perfectly round, but it has a slight teardrop shape. This can be attributed to mere carelessness, as the next hole below is not very neatly shaped either. However, excavated medieval bone flutes show a variety of window shapes, such as a standing rectangle, foursquare, triangle, oval, circle and stirrup shape (Brade, 1975, pp.33–36; Leaf, 2008, pp.102–105). Therefore, the teardrop shape in the Mätäjärvi flute could also be intentional. The lower rim of the window seems to suggest that the maker of this artefact intended a slight bevel. This is not unusual, as in most excavated bone flutes, the lower rim of the window appears to be cut with a bevel not as sharp as in most wooden or modern recorders. For example, the bone flute from Deventer, the Netherlands, has a rectangular window with a lower rim that is cut out vertically, not oblique (See Figure 7).

Regarding finger holes, a number of three is prevailing in the European bone flute finds (Brade, 1975, pp.36–37; Lund, 1985). A thumbhole that is common in recorders is lacking in most cases. These features enable the player to hold and play the flute with one hand only, as the thumb and the little finger are not used to close up holes, and they can support the flute during the playing (Bosmans, 1991, pp.69–78; Montagu, 1997). In the Mätäjärvi flute with one

broken end, the original length of the tube and the number of the finger holes are unknown to us. If the maker used the full length of the bone, there was enough room to make three evenly spaced finger holes. The fact that the existing finger holes are positioned rather close to the window also speaks in favour of three finger holes. If two finger holes were intended, these would have been placed at a larger distance from the window. The possibility that just two finger holes were realized or intended cannot be ruled out. Hence, we decided to make two experimental reconstructions.

Reconstructing the Mätäjärvi Flute

In order to make a reconstruction that was as close as possible to the original flute, sheep tibiae of practically the same dimensions as the Mätäjärvi find were needed. Most sheep breeds kept and slaughtered nowadays are of a much heavier build than medieval ones (Figure 8a). Bones of sheep of old breeds, more closely resembling the find, are not easy to come by. By chance, we had access to two excavated sheep tibiae that were unprovenanced and discarded and close to the shape and dimensions of the Mätäjärvi bone (See Figure 8b). We decided to use them. A disadvantage of these old excavated bones was that both of them – by their stay in the ground – proved to be calcified to such a high degree that it was impossible to use a knife to process them. Instead, a drill and files had to be used. The calcified bone was very solid and polished compared to a fresh bone. Although the manufacturing methods used by a medieval bone flute maker are unknown to us, it is probable that the sheep bone selected for making the flute was not processed fresh, but was cooked first in a broth to extract the edible marrow. The bone hardens when cooked, though not as hard as a calcified bone, and absorbs some fat from the marrow, effecting in a smooth surface. Therefore, the differences between the original material and the material we used may not be as big as one might initially think. Moreover, the material of the flute should not have a significant effect on the sound of the instrument, as it is mainly the size and shape of the vibrating air column that determine the pitch and timbre.

Two reconstructions were made: one with two finger holes, the other with three finger holes (See Figure 9). Unfortunately, the bone with two finger holes appeared to have a hair crack that came to light when the reconstruction was played for the first time. Bone as a material is very sensitive to moisture. When playing, the warm moisture of the breath expands the bone, in this case resulting in an expanding crack that did resist mending. Hence the experimental playing of the Mätäjärvi flute could be executed with the three-holed reconstruction only. In the three-holed version, the undulating projections from the closed lower end of the bone were left on. A hole was drilled slightly smaller than the diameter of the tubular bone, narrowing thus the bore slightly towards the end. This narrowing can extend the range and bring overblown notes more in tune (Montagu, 2007, p.59). Beeswax can be applied for this effect too. As the lower end of the Mätäjärvi flute is lacking, this detail is a conjecture.

For the reconstructions of the block, we used both beeswax and cork (See Figure 10). Beeswax was chosen for the two-holed reconstruction because it is a convenient and pliable material, easier to fit tightly into the irregular inside shape of the bone than a block made of wood. When establishing experimentally what shape would be needed to sound the flute, beeswax is easy to work. As the wax will stick to the inside of the bone, little support is needed to prevent the block from falling out. The disadvantage of beeswax is that it is vulnerable to damage in the windway over time. Therefore, cork was chosen for the three-holed reconstruction that was used for experimental playing. Cork is elastic and can be fitted into the interior of the bone without exerting too much pressure. This seemed important considering the tendency of the old bone to crack. A disadvantage of cork is its irregular structure that could influence the airflow in the duct. In order to smoothen the surface of the windway, the surface of the cork was covered with beeswax. Although, at first sight, the slanting beak of the Mätäjärvi flute seemed to give extremely little support to the block, the reconstructions proved that it provided enough contact surface to hold a block. After some finishing touches, the reconstructions of the Mätäjärvi flute were complete and ready to give impressions of sounds heard some six hundred years ago.

Playing the Reconstruction

To carry through the archaeo-musicological experiment, the reconstruction with three finger holes was played for over a year by a professional flutist and sound artist, who has training in western concert flutes but also wide experience in other types of flutes, pipes, and tubes. The reconstruction was played, if not daily, on a regular basis. This lengthy practice turned the worked sheep bone into a sounding instrument and yielded in-depth, experiential and embodied information on its musical and technical characteristics. Additional information on the physical sound characteristics was acquired using the *Spectutils* spectrum analysis tools (Lassfolk and Uimonen, 2008). As the reconstruction is very similar to a number of archaeological flute finds in Europe, its characteristics can be seen to reflect essential traits of medieval bone flutes, though at a very general level.

The first impression of the flute is that it is easy and light to play. The pressure and the shape of the air needed to blow it should be quite small and soft. This lightness contrasts sharply with classical flute playing and western concert flutes that require a more forceful approach. It also suggests that this flute can be played for a long time, and even children could have played it. The second impression is that only one hand is actually needed for playing. The three finger holes can be closed using the index, the middle and the ring fingers of the same hand, while the thumb and the other hand support the tube (See Figure 11). A more natural choice for this fingering appears to be the left hand. It is interesting to note that in medieval illustrations, flute players, minstrels or shepherds, often use only one hand for playing, while the other hand beats a drum or holds a bell or a staff (Bosmans, 1991, pp.69–78; Montagu, 1997, pp.28–30). Although the depicted flutes in these sources are wooden, so-called tabor

pipes, bone flutes with two or three finger holes could well have been played with the same technique. In this case, the little finger should have assisted the thumb in supporting the tube.

By covering and opening the three finger holes of the flute, it is possible to produce three or four different tones or pitches. In principle, the more finger holes are closed (as seen from above), the lower the tone becomes. Surprisingly, the covering of the lowest hole in this flute raises the pitch, which suggests that there might be some kind of block in the lower part of the tube, preventing the air from running freely through the tube. However, this feature, or defect, did not necessarily show in the original flute because it involves the missing and hypothetically reconstructed part of the fragmentary find. As expected in a flute of this length, the frequencies of the playable tones or pitches are quite high. The fundamental of the first sounds at 1910–1945 Hz, the second at 2150–2222 Hz, the third at 2369 Hz and the fourth at 2460–2650 Hz (See Figure 12). These frequencies correspond to the notes A#6+42–B6-27, C7+47–C#7+4, D7+14 and D#7-20–E7+9 in the Western musical tuning system. As adding the air pressure raises the pitch of the flute effectively, the given values are only estimates, open to modification. According to spectrum analysis, each of the playable tones has five to seven relatively strong overtones that add clarity and brightness to the sound. The sound of the air cannot be heard that much, probably because the tube is too narrow to allow the air to hiss. Overblowing is not successful.

The musicality of the flute lends itself to producing long and meditative sounds. The player is enticed to blow long whistles and long tunes and to wander around in the three, four pitches, enjoying the light and bright sound. This type of sound and playing probably carries well and is audible from a distance. The first two strongest harmonics of the tones fall on the most sensitive range of human hearing (2000–5000 Hz) and stand therefore easily out from common, usually much lower, background noise. The sound of the flute can be seen to refer to medieval marketplace music playing and also to shepherds' playing, almost whistling to their pipes. The music produced from the flute was found by our listeners to be mesmerizing and invites the player to explore its range and pitch (supplementary materials: Sound sample).

After playing the flute for approximately 15 minutes, it begins to warm up and the sound changes. The sound becomes even brighter, deeper, more resonant, more luminous and louder also when wanted. The dynamic range becomes more flexible and extensive. This effect is familiar to the experienced bone flute players, who preferably carry their flutes on the neck or the breast, under the clothes, to keep their instruments warm and ready to play. The effect is probably overly pronounced in our reconstruction that is made of an extremely dry and hard medieval bone. In the original instrument, the effect might have been less obvious. For the sake of comparison, in the future, it would be interesting to carry out a similar playing experiment with a flute of fresh sheep bone.

What Was the Intended Use of the Flute?

In medieval written and iconographic sources, flutes and flute playing are often associated with minstrels or jongleurs, that is, wandering musicians, acrobats and entertainers, who travelled from town to town and performed at streets, market places and more private gatherings (Salmen, 1960; Montagu, 1976; 2007). These types of musicians with flutes are reported, for example, from 13th–16th century Germany, Sweden, Poland, Lithuania, and Novgorod (Olaus Magnus, 1555, pp.521–523, 629; Salmen, 1972, pp.73–94; Leisiö, 1983, pp.49–51). Although there is no corresponding information from Turku, minstrels most probably visited this burgeoning town along the Baltic Sea trade routes, introducing people to their instruments and musical styles (cf. Haavio, 1932). Surnames like Pipare ('Piper'), Lekare or Leikari ('Player'), mentioned in 15th-century Finnish records, might refer to these professionals (Andersson, 1963, pp.24–26). However, a problem in this connection is that the flutes played by the minstrels appear to be mostly wooden flutes: long recorders with six or seven finger holes or even longer three-holed tabor pipes that were played with one hand together with a drum (Salmen, 1960; Leisiö, 1983, pp.49–51; Montagu, 1997; Leaf, 2008, p.28). Bone flutes might have been played by the minstrels, too, but there are obviously no direct proofs of that. Furthermore, the flute from Turku does not come across as an instrument of a professional wandering musician. Its incomplete state suggests that the artefact was fabricated locally in Turku, probably quite close to the place where the fragment was unearthed. The rough outlook and unsuccessful realization even imply that the maker was not necessarily very experienced in flute making.

In later European folk tradition, simple wind instruments, flutes and reed pipes were mostly associated with shepherds, who used sound for signalling to their animals, other shepherds or folks at home, for amusing themselves or for frightening away predators from the flock (Leisiö, 1983; Moeck, 1996). Shepherds or ragmen using explicitly bone flutes are reported from 19th–20th century Greece, Sweden, Norway and Slovakia (Megaw, 1961; Elschek, 1983, pp.144–150; Lund, 1985, pp.19–22). However, most of the shepherds across Europe used flutes, reed pipes, or trumpets made of plant material, such as wood, bark, reed, or vascular plant. This preference for plant material applies especially to 19th–20th century Finland, where folky wind instruments made of bone were completely unknown (cf. Leisiö, 1983). Therefore, in relation to later Finnish folk tradition, the bone flute finds from medieval Turku are really exceptional. Even so, their interpretation as possible shepherds' instruments seems plausible. The osteological material from the urban excavations indicates that domestic animals, such as cattle, sheep, goats and pigs, were kept abundantly in medieval Turku (Tourunen, 2008, pp.36–39, pp.79–80). The block where the studied flute was found included a probable shelter for animals, and the associated layer M 147 included a large number of animal bones. These animals, at least the cattle and sheep, must have been taken to pasture outside the town in summer and herded by a shepherd or alike. In winter, many sheep had to be slaughtered to pre-empt winter-feeding problems (Tourunen, 2008, pp.30–31, p.40),

meaning that a lot of bones were available. Under these circumstances, it does not seem far-fetched to think that shepherds in Turku, who were exposed to overseas influences, sometimes used bone flutes, in addition to those made of plant material.

Was the studied flute a trial piece made by a shepherd themself or by an artisan in the Quarter of Mätäjärvi? A definite answer to this question is out of reach, of course, but it is possible to speculate about it by following the lead provided by the archaeological record. The Quarter of Mätäjärvi appears to have been predominantly an artisan district. So far, no traces of professional production of bone artefacts have been detected, though the horn cores dumped in Mätäjärvi might be associated with horn working (Vuorisalo and Virtanen, 1985; Tourunen, 2008, pp.76–77), and worked horse bones concentrated under the courtyard pavement of the dwelling house RA 186 might be associated with bone working, taking place at the end of the 14th century (Tourunen, 2008, pp.130–132). At the beginning of the 15th century, the block around the same courtyard pavement contained a probable tanner's or shoemaker's workshop and a large amount of waste material related to leatherworking. Shoemaking and tanning were closely connected to animal husbandry because shoemakers in the Middle Ages used to tan their own leather and process the hides (Tourunen, 2008, pp.37–39; pp.125–126). On the basis of the abundant bone material in layer M 147, they even killed and skinned animals on their premises (Tourunen 2008, p.54, pp.79–80, pp.108–110, p.130, p.143), leaving plenty of raw material for bone working. Thus, it would seem logical that bone artefacts, including bone flutes, were produced on the same premises seasonally or semi-professionally, as by-products of other crafts (cf. Tourunen, 2008, p.131). This semi-professionalism would also explain the rough outlook and incomplete state of the studied bone flute, a relatively rare, newish product.

For the most part, the material found in layer M 147 provides only general information about the activities around the location. Still, the beater of a Sámi shaman drum, hidden under the floor of the dwelling house RA 186, bears witness to a more specific incident. Could the two musical instruments in the same layer be somehow connected? Was the flute perhaps meant to be played together with a drum? A combination of a flute and a drum recalls the medieval minstrels, who played both of these instruments deftly at the same time. However, the Sámi-style beater is basically associated with quite a different type of music-making, namely, intensive drumming or rolling meant to induce trance states in shamans (e.g., Manker, 1938). As far as known, the Sàmi shamans did not play any wind instruments in their séances, but they whistled to summon rain, thunder and northern lights (Paulaharju, 1922, pp.213–215; Manker, 1957, pp.229–230). Shamanic rituals in Siberia seem to have included whistling sounds produced with flutes and reed pipes (e.g., Znamenski, 2003, pp.241–242). Taking into account that the anthro-zoomorphic staff, also hidden in the dwelling house RA 186, resembles wooden or iron zoomorphic staffs used by some Siberian shamans (Diószegi, 1963, pp.57–64, p.76; Konovalov *et al.,* 2006, pp.173-178), one starts to wonder: Could it be that shamanistic seances were held in early 15th century Turku, in the dwelling house RA 186?

Before jumping to wild conclusions, it might be useful to elaborate on the archaeological facts. Firstly, remains of an actual drum were not found in the dwelling house RA 186, not even iron fittings, rings, or other usual accessories of a drum that could have been preserved in the ground (cf. Manker, 1938, pp.267–283, pp.355–364). This hints at a possibility that there was no drum in the dwelling house, only the beater. Secondly, the beater was found among the birch bark insulates that were lined up neatly under the floorboards (Pukkila *et al.,* 2000, p.62, K. 201, p.202; Seppänen, 2012, pp.413–414). Thus, it was not necessarily easy to take the beater out of this hide. Archaeologists have been inclined to interpret the two hidden artefacts as ritual deposits, gifts to the house spirit that were meant to bring good luck and to protect the household from evil forces (Seppänen, 2012, pp.417–417; Hukantaival, 2016, p.83, Appx 3: 24). The artefacts in this function were only lying in their concealments – there was no need to see, touch or play them in practice.

Conclusion

In this article, we have focused on one particular bone tube excavated in the Mätäjärvi Quarter of Turku to expand and enrich the knowledge of medieval bone flutes. Although this particular find is fragmentary and far from being a showpiece item, it provides some snapshots of flute making and playing on the fringes of Europe in the 14th–15th centuries. In terms of structure and material, the studied flute is a typical block-and-duct flute with two or three finger holes made from a sheep shin bone. However, the rough-hewn and unfinished details suggest that the maker was not very experienced or specialized in this type of instrument. The artefact was probably fabricated locally in the artisan district of Mätäjärvi as a by-product of other craft activities. The reconstruction process highlights the fact that accurate reproductions of the medieval bone flutes can only be made using bones of old, historical sheep breeds. As our reconstructions meet this requirement, they provide a rare opportunity to explore the musical and technical characteristics of these medieval instruments. According to the playing experiment carried out with the three-holed reconstruction, the flute is easy and very light to play. The lightness inspires one to long, meditative playing, wandering around in the three, four pitches, enjoying the bright and carrying sound. Only one hand is needed for playing. Owing to that, the other hand is left free to hold something else, for example, a shepherd’s staff or crook.

Supplementary materials

SOUND SAMPLE: FREE IMPROVISATION PLAYED WITH A RECONSTRUCTION OF THE MEDIEVAL SHEEP SHIN BONE FLUTE EXCAVATED IN THE TOWN OF TURKU, SW FINLAND. THE ORIGINAL FRAGMENTARY ARTEFACT, DATING FROM THE LATE 14TH CENTURY TO THE FIRST HALF OF THE 15TH CENTURY, BELONGS TO THE COLLECTIONS OF THE MUSEUM CENTRE OF TURKU (TMM 21816: LU54). THE HYPOTHETICAL RECONSTRUCTION WITH THREE FINGER HOLES WAS MADE FROM AN UNPROVENANCED MEDIEVAL SHEEP SHIN BONE BY ANNEMIES TAMBOER. THE RECONSTRUCTION IS PLAYED BY TAINA SAARIKIVI. PHOTO CREDIT TO TESSEL GRIJP, XANDER RIJKEE AND JULIA SHPINITSKAYA: HTTPS://YOUTU.BE/FRHKWKUKXLC

Keywords music & musical instruments

Country Finland

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Corresponding Author

Riitta Rainio
University of Helsinki
Department of Cultures
Fabianinkatu 24 Room 132
00014 Helsinki
Finland
E-mail Contact

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FIG 1. BONE FLUTE TMM 21816: LU54 EXCAVATED IN THE MEDIEVAL QUARTER OF MÄTÄJÄRVI IN TURKU, FINLAND. PHOTOS BY THE AUTHORS/MUSEUM CENTRE OF TURKU.

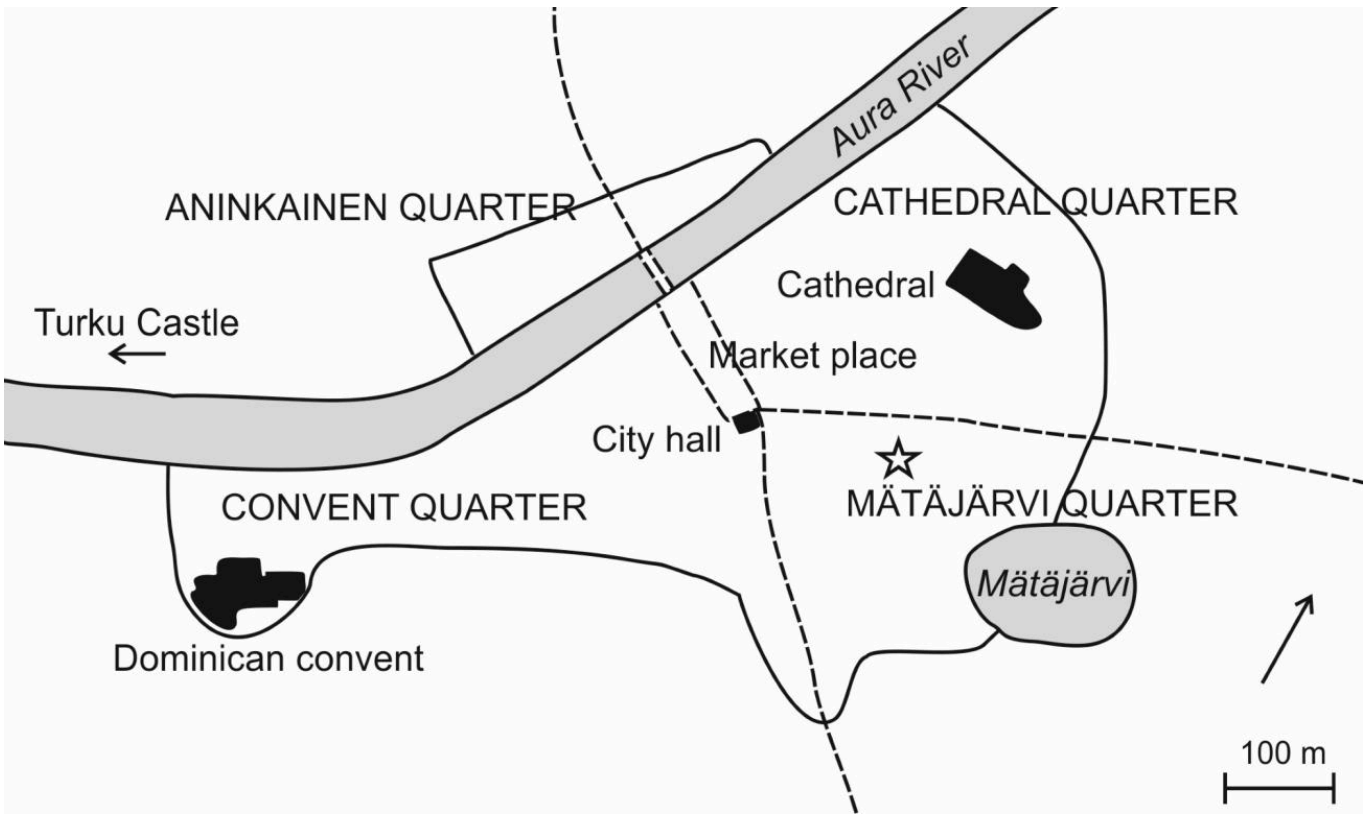

FIG 2. MAP OF THE TURKU TOWN SHOWING ITS QUARTERS AND THE MOST IMPORTANT BUILDINGS AND ROUTES IN THE 15TH CENTURY. THE FIND LOCATION OF THE MÄTÄJÄRVI FLUTE IS MARKED WITH A STAR. REDRAWN AND MODIFIED FROM AHOLA ET AL. (2004: 82) BY THE AUTHORS.

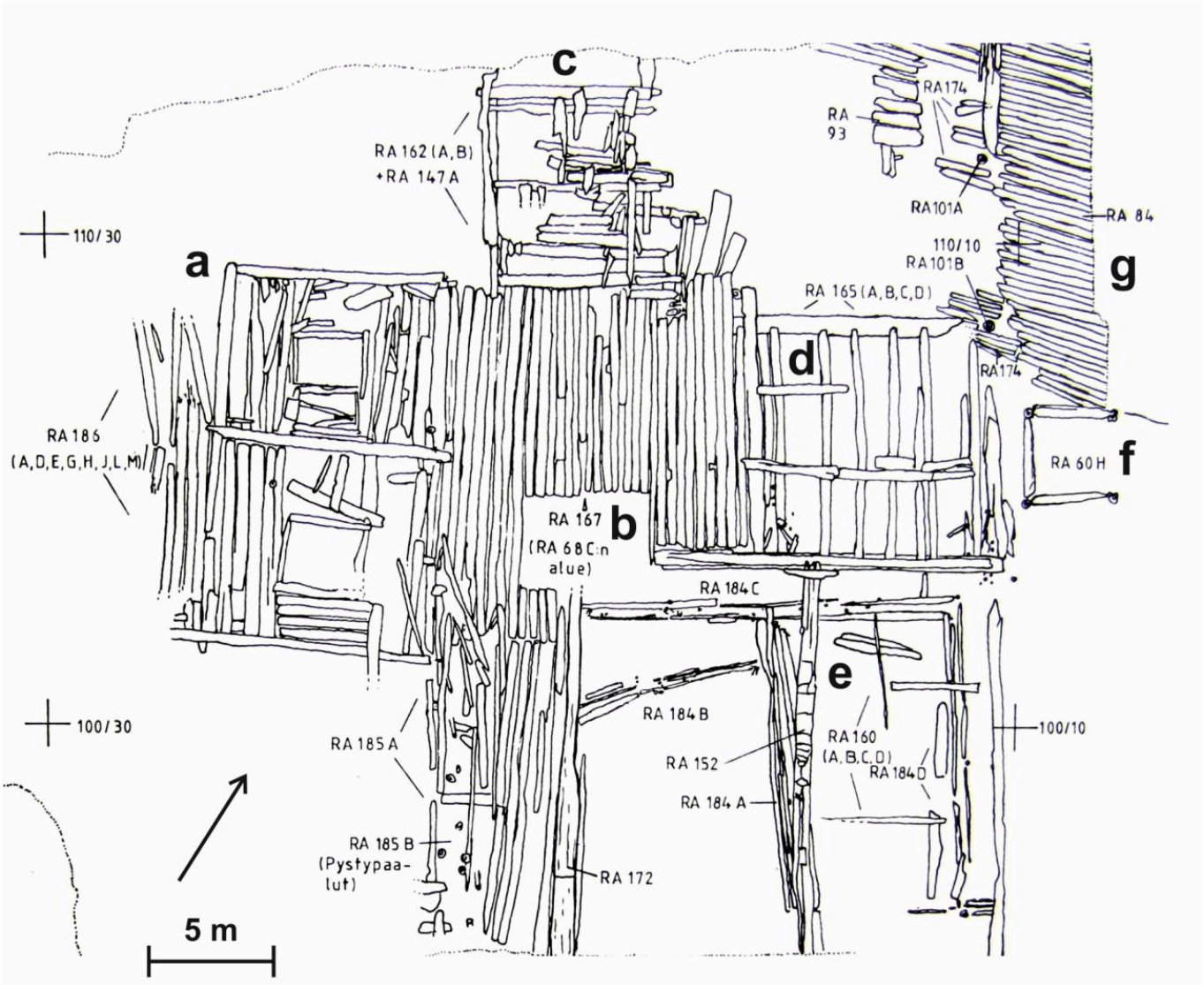

FIG 3. EXCAVATION MAP SHOWING THE BLOCK OF LATE 14TH, EARLY 15TH CENTURY BUILDINGS, WHERE THE MÄTÄJÄRVI FLUTE WAS FOUND: A) DWELLING HOUSE WITH TWO ROOMS, B) COURTYARD WITH WOODEN PAVEMENT, C) PROBABLE SHELTER FOR DOMESTIC ANIMALS, D) SHOEMAKER'S OR TANNER'S WORKSHOP, E) WATER CHANNELS AND TRACES OF A DRYING RACK, F) WELL, G) PAVED STREET. AFTER PUKKILA ET AL. (2000: MAP 316).

FIG 4. CLOSE-UPS OF THE MÄTÄJÄRVI FLUTE: A) CONICAL CAVITY AT THE UPPER WIDE END; B) CROSS-SECTION OF THE LOWER NARROW END. PHOTOS BY THE AUTHORS/MUSEUM CENTRE OF TURKU.

FIG 5. CLOSE-UPS OF THE MÄTÄJÄRVI FLUTE: A) HUMAN-MADE HOLE NEXT TO A TRANSVERSE CUT AT THE LOWER NARROW END; B) SLANTING BEAK AT THE UPPER WIDE END, INTERPRETED BY US AS THE MOUTHPIECE OF THE FLUTE. PHOTOS BY THE AUTHORS/MUSEUM CENTRE OF TURKU.

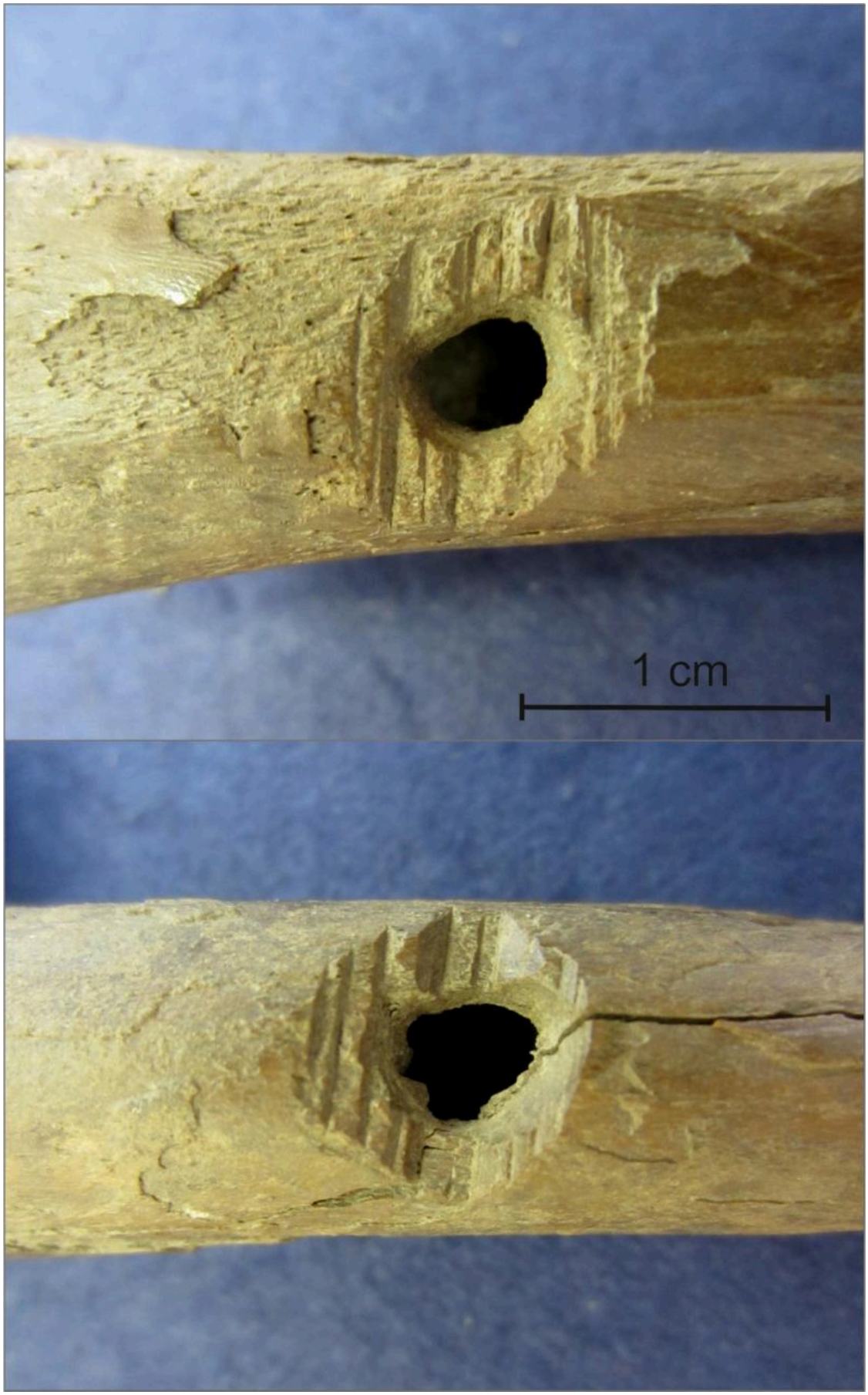

FIG 6. CLOSE-UPS OF THE MÄTÄJÄRVI FLUTE: A) HOLE NEAR THE UPPER WIDE END, INTERPRETED BY US AS THE SOUND HOLE OR WINDOW OF THE FLUTE; B) HOLE IN THE MIDDLE OF THE TUBE, INTERPRETED BY US AS A FINGER HOLE OF THE FLUTE. PHOTOS BY THE AUTHORS/MUSEUM CENTRE OF TURKU.

FIG 7. MEDIEVAL BONE DUCT FLUTE MADE FROM A SHEEP TIBIA, EXCAVATED FROM A MOAT ROUND A MONASTERY IN DEVENTER, THE NETHERLANDS. POSSIBLY 13TH CENTURY. THE (SHRUNKEN) WOODEN BLOCK IS STILL IN ITS PLACE. PHOTO BY THE AUTHORS/PROVINCIAL DEPOT A. VERLINDE, DEVENTER.

FIG 8. UNWORKED SHEEP TIBIAE: A) BONE OF A RECENT STURDY BREED; B) MEDIEVAL, UNPROVENANCED AND DISCARDED BONE USED FOR MAKING THE RECONSTRUCTION. PHOTOS BY THE AUTHORS.

FIG 9. TWO HYPOTHETICAL RECONSTRUCTIONS OF THE MÄTÄJÄRVI FLUTE: A) VERSION WITH TWO FINGER HOLES; B) VERSION WITH THREE FINGER HOLES. PHOTOS BY THE AUTHORS.

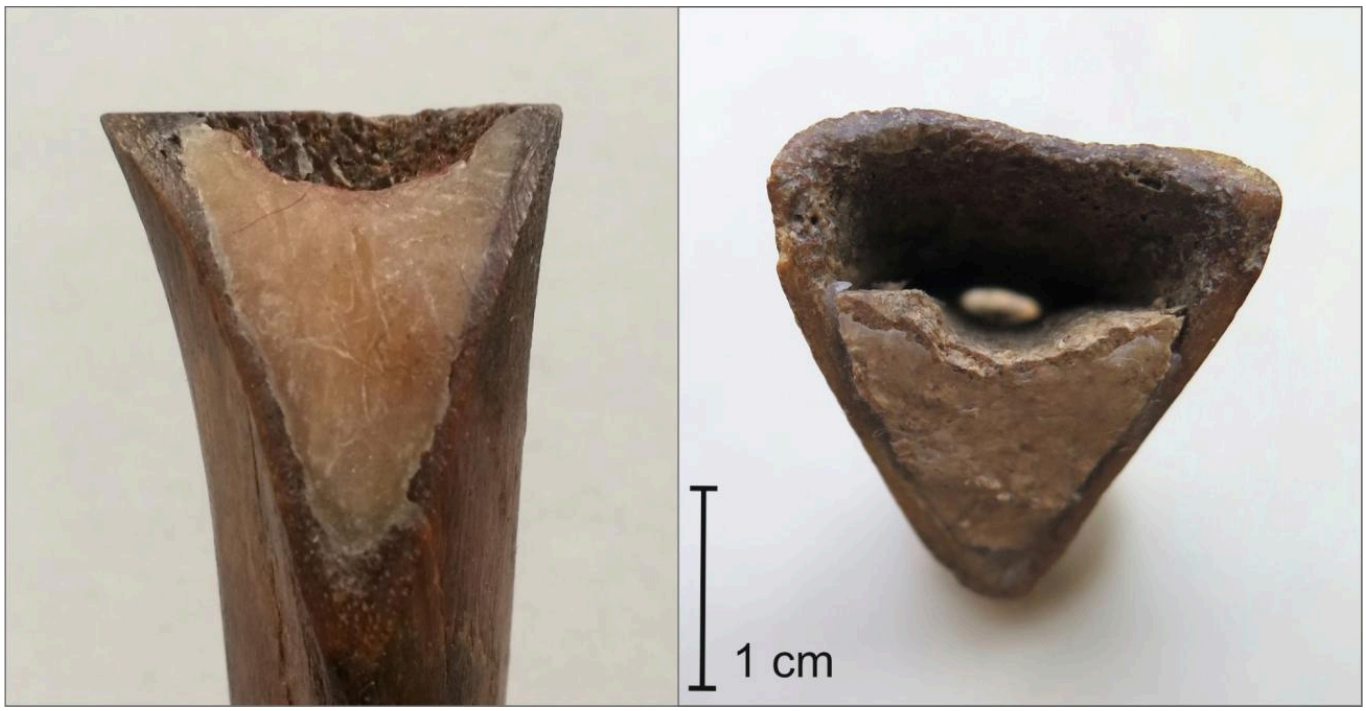

FIG 10. BLOCKS USED IN THE RECONSTRUCTIONS: A) VERSION MADE OF BEESWAX; B) VERSION MADE OF CORK. PHOTOS BY THE AUTHORS.

FIG 11. “LOOKING FOR SHEEP”: XANDER RIJKEE DEMONSTRATING THE PLAYING POSTURE AND FINGERING OF THE THREE-HOLED RECONSTRUCTION. PHOTO BY TESSEL GRIJP.

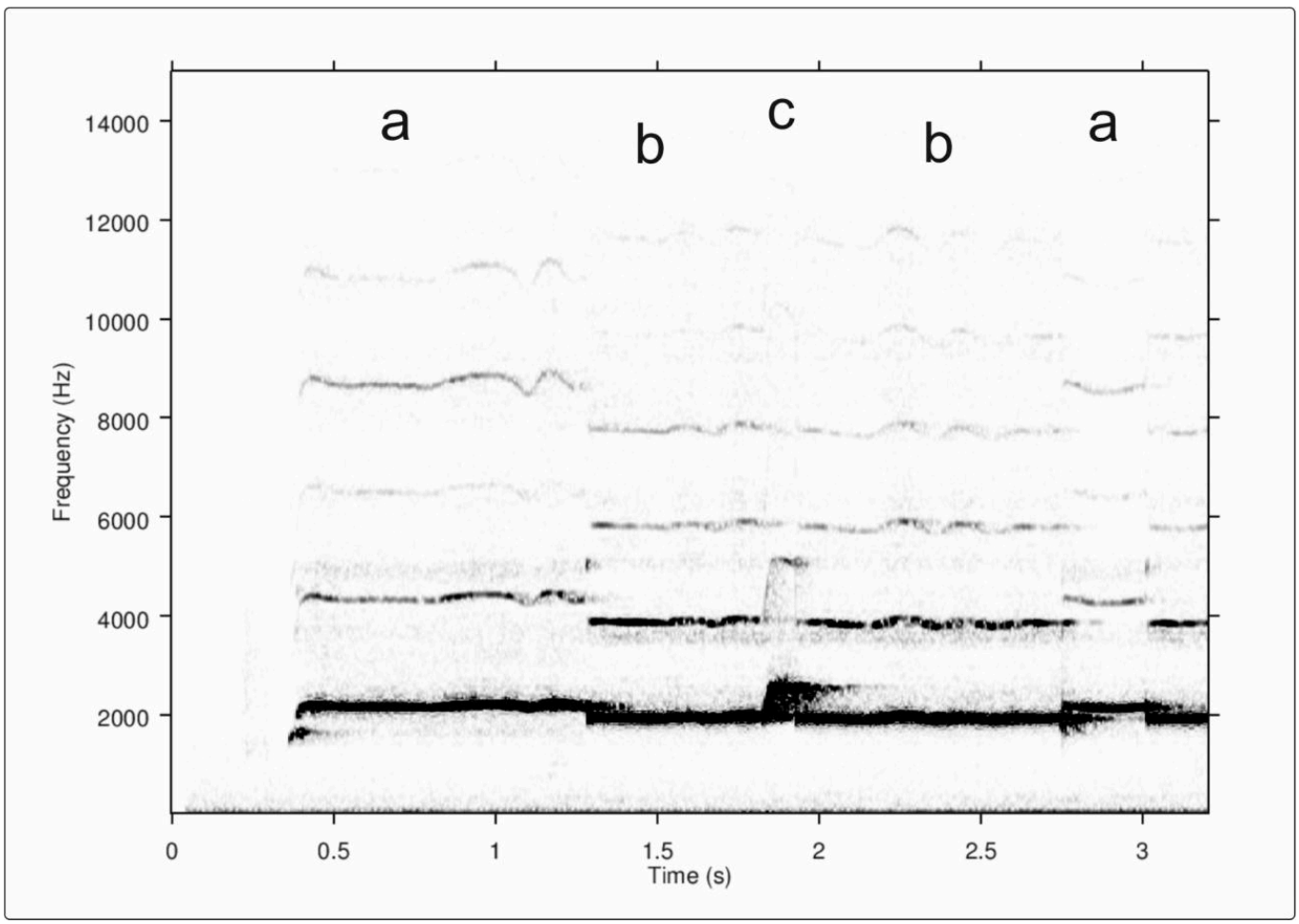

FIG 12. SPECTROGRAM SHOWING THE SOUND FREQUENCIES DURING THE FIRST THREE SECONDS OF SOUND SAMPLE: A) TONE 2150–2222 HZ WITH ITS OVERTONES, B) TONE 1910–1945 HZ WITH ITS OVERTONES, C) TONE

2460–2650 HZ WITH ITS OVERTONES. THE AMPLITUDE OF THE FREQUENCIES IS REPRESENTED BY THE INTENSITY OF THE GREYSCALE. PLOT BY RIITTA RAINIO.