



SOUND TOOL OR A FISHERMAN'S TOOL?

An Experimental Approach to the Mesolithic Bird Bone Artefact from the "Antrea Net Find"

ABSTRAKT

ETT BLÅSINSTRUMENT ELLER ETT FISKEREDSKAP? EN EXPERIMENTELL SYNVINKEL PÅ ETT MESOLITISKT FÅGELBEN SOM PÅTRÄFFATS I "NÄTFYNDET FRÅN ANTREA"

Det välkända mesolitiska nätfyndet från Antrea innehåller bl.a. ett föremål som är tillverkat av ett sångsvansben (Cygna cygnus). Den ena ändan på detta rörformiga föremålet har en u-formad skåra som påminner om munstycket till ett blåsinstrument. Denna studie tar upp fyndets funktion i ett nytt ljus genom att göra kopior och modeller av föremålet och genom att testa dem i praktiken. Kopiorna fungerar ypperligt som en rörlöjt och som en vasspipa, men små strukturella detaljer påvisar att den som tillverkade föremålet inte hade för avsikt att tillverka ett blåsinstrument. En mera trovärdig förklaring vore att den fungerade som ett fiskeredskap: för att fjälla fisk, avbarka träd eller för att reparera fisknät. Även om experimenten inte ger en entydig förklaring på föremålets funktion påvisar de att den tidigare tolkningen om föremålet som ett blåsinstrument eller flöjt är osannolik.

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INTRODUCTION

In 1913, the remains of a fishing net were discovered by local landowner Antti Virolainen at the village of Korpilahti in the former Finnish municipality of Antrea in the Karelian Isthmus.¹ Today the area is part of the Russian municipality of Ozerskoje in the St. Petersburg region, Vyborg district (Fig. 1). During the excavations by Sakari Pälsi in 1914, the remains of a willow (*Salix* sp.) bast net, sinkers, floats and bone and stone artefacts were found (Fig. 2).² Palynological investigations have revealed that the material was deposited in the sediments during the maximum of the Ancylus transgression, when Korpilahti was a strait in the Ancylus Lake.³ Archaeologists have interpreted that the net and other items were accidentally lost in the waters of the Ancylus Lake⁴ when the net was not set for fishing.⁵ The surroundings of the site consisted of a broken archipelago. Radiocarbon dates taken from the bark floats and the net itself have given an age of circa 8100 cal BC.⁶

Osteological material from this find, traditionally called the “Antrea net find”, was first studied and analysed in the early twentieth century. Danish osteologist Herluf Winge⁷ identified bones of the European elk (*Alces alces*) and whooper swan (*Cygnus cygnus*). Bone and antler artefacts include a spearhead, a gouge and bevelled-edged artefacts.⁸ The bone material was re-investigated by Kristiina Mannermaa and Pirkko Ukkonen in 2002.⁹ Because Stone Age finds with well-preserved bone materials and complete bone ar-



Fig 1. Location of the site of Korpilahti in Antrea, the Karelian Isthmus.

tefacts are extremely rare in Finnish archaeology, the Antrea find has a very special role in Finnish archaeology.

Among the swan bones are two humeri (NM 6688: 6, 28), which Ville Luho¹⁰ interpreted to be some type of 'chisels' or gouges. Cajsa Lund¹¹ was the first person to pay closer attention to these swan bones, suggesting that they could be sound instruments, a specific type of flute. Later Timo Leisiö¹² also wrote about potential flutes, and the flute hypothesis was included in the exhibition text at the National Museum of Finland. The bones were studied again in 2005, when their function was discussed by Mannermaa.¹³ According to her, the humerus with the inventory number NM 6688: 6 does not have any visible signs of working, whereas another humerus NM 6688: 28 has been worked on the distal part (Fig. 3). However, the proximal part appears unworked. The edges of the distal part are flat, smooth and covered by delicate striations.¹⁴ The ventral side has been flattened or bevelled with a rough object but not polished (Fig. 3a, 4b–d). On the opposite dorsal side, a longitudinal crack runs down through the bone (Fig. 3b, 4a). A wider opening exists near the distal end, possibly forming a hole in the crack. The surface of the bone

is eroded with flaking and pitting. Based on the playing tests on the copy, Mannermaa¹⁵ concluded that artefact NM 6688: 28 (later the Antrea artefact) was at least not an end-blown flute. The bevel or notch on the distal end is sufficiently deep (2.4 cm) that the air blown in escapes before reaching the tube.

This study will further test the previously mentioned potential functions of the Antrea artefact. Our focus is mainly on sound instruments, more precisely air-operated wind instruments, but other possible lines of interpretation will also be kept open. To obtain reliable information on the artefact's sound-related use, the diverse voicing methods and struc-



Fig 2. The Antrea net find in situ: bark floats in front, stone sinkers behind. Photo: National Board of Antiquities.



Fig 3. Worked humerus of a swan (*Cygnus cygnus*) from Antrea: a) the bevelled side, b) the cracked side. Photos: National Board of Antiquities.

tural variations found in the family of wind instruments must be taken into consideration. Requiring special expertise, this specification was carried out in November 2014, when the authors of this article convened in the Singing Bone Workshop held at the University of Helsinki. In connection to this workshop on experimental music archaeology, several copies and type models of the Antrea artefact were made from Mute swan (*Cygnus olor*) and goose (*Anser sp.*) humeri and tested in practice. Sound samples were recorded and analysed at the University of Helsinki Music Research Laboratory studio.¹⁶ Although the workshop also had several other objectives, the gathering afforded an opportunity to identify whether this object was really one of the oldest wind instruments of North Europe, which absorbed the most attention from the participants. The oldest North European flutes found thus far date back to the Neolithic.¹⁷ The oldest flute- or clarinet-like artefacts, bone tubes with possible finger holes, are found in Germany and France, and they date to the Upper Paleolithic, up to 35 000–43 000 cal BP.¹⁸

BACKGROUND ON WIND INSTRUMENTS

Understanding wind instruments and their acoustics requires that certain basic principles and concepts of the field of organology¹⁹ be familiar to the reader. To make a wind instrument, a cylindrical or conical tube would normally be needed because the vibrating air column in the tube primarily pro-

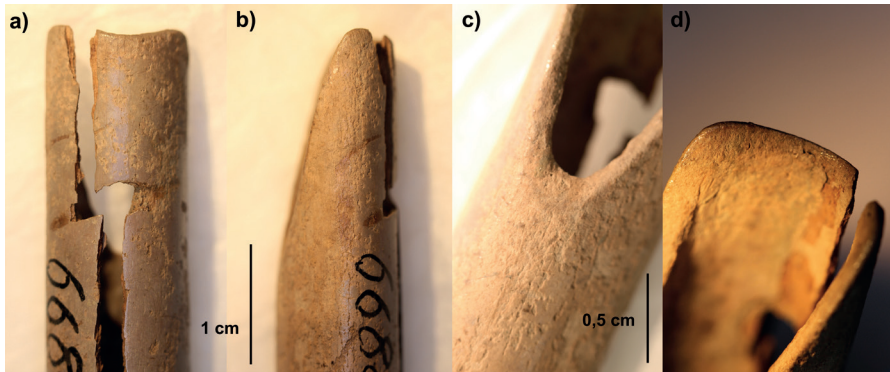


Fig 4. Close-ups of the worked end of the Antrea artefact: a) the cracked side with a hole, slightly concave edge and abraded surface, b) oblique cut in profile, c) the curve of the notch on the bevelled side, d) the sharp edge on the bevelled side. Photos: Kristiina Mannermaa.

duces the sound. Swan wing bones, which are naturally hollow and long, are particularly well suited to this purpose and have been used since the Upper Paleolithic.²⁰ At least one end of the tube, the blowing end, must be cut and opened, whereas the other end can be closed or open. In the case of swan humeri, a natural hole at the proximal end allows the air to escape, even if the epiphysis is not removed.

To vibrate the air column inside the tube, the blowing end must be further modified in one of the following ways: 1) By bevelling or notching the end so that it becomes sharp and sets the air vibrating when the player blows across the end (end-blown flutes). 2) By carving a hole near the blowing end and channelling air to it with a special block, the tongue or the lower lip. The edge of this hole or window causes the air to vibrate when the player blows across the end. A notch, in this case, facilitates the insertion of the block (duct flutes). 3) By attaching a flexible reed or lamella to the blowing end and blowing through it. The vibrating reed, which can be either idioglottal²¹ or heteroglottal²², sets the air in motion. In this case, the notch enables the attachment of the reed (reed pipes or clarinets).²³ The ends of archaeological bone tubes are usually so poorly preserved that it is impossible to say which one of these voicing methods was actually used. For example, this situation applies to most possible Upper Paleolithic wind instrument finds.²⁴ The Antrea find, with its well-preserved worked end, is a positive exception to this rule, enabling detailed experimental models to be made and used. The first (end-blown flute) method was already tested on the Antrea artefact by Mannermaa.²⁵ The second (duct flute) and the third (reed pipe) methods will be tested and reported on in this study.

A vibrating air column in a tube creates a sound with certain pitch, that is, a sound with harmonic structure. Because the length of the tube determines the pitch, several pitches can be obtained by carving finger holes, which enable the effective tube length to be changed. The finger holes are characteristic of many wind instruments but are not necessary if the player is satisfied with only one pitch. Slighter variations in sound can be obtained by modifying the blowing angle, the force of the air flow, and the size of the opening at the farther end. Many traditional whistles and animal calls have no finger holes and only employ the latter methods.²⁶ Thus, the absence of successive holes on the shaft of the Antrea artefact cannot be used as evidence against the wind instrument hypothesis.

TESTING THE ARTEFACT AS A DUCT FLUTE

As a whole, the worked end of the Antrea artefact fits the description of the blowing end of a duct flute. The opening or hole on the cracked side of the bone is in the right position to act as a window to set the air vibrating. The U-shaped notch on the opposite side is too deep to permit a separate block to be inserted but shaped perfectly to accommodate the lower lip or tongue of the player. Similar combinations of a hole and a notch can be found in the traditional lip or tongue duct flutes, which were usually made from bark in nineteenth–twentieth century Finland.²⁷ Another parallel example may be found on a medieval flute found in Sweden that was manufactured from a sheep tibia.²⁸ The oldest possible lip or tongue duct flute found thus far is Neolithic and comes from Solsem Cave in Norway.²⁹ With its clearly man-made hole and a notch, this bone artefact appears almost identical to the Antrea artefact.

To test the Antrea artefact as a lip or tongue duct flute, Swedish instrument maker Åke Egevad made a type model from swan bone for the Singing Bone Workshop. The structure and proportions of the worked end were exactly the same as in the original artefact. No additional material was needed. When the worked end of the finished type model was inserted into the



Fig 5. Type model of the Antrea artefact played by Cajsa S. Lund as a tongue duct flute. Photo: Aino Lund Lavoipierre.

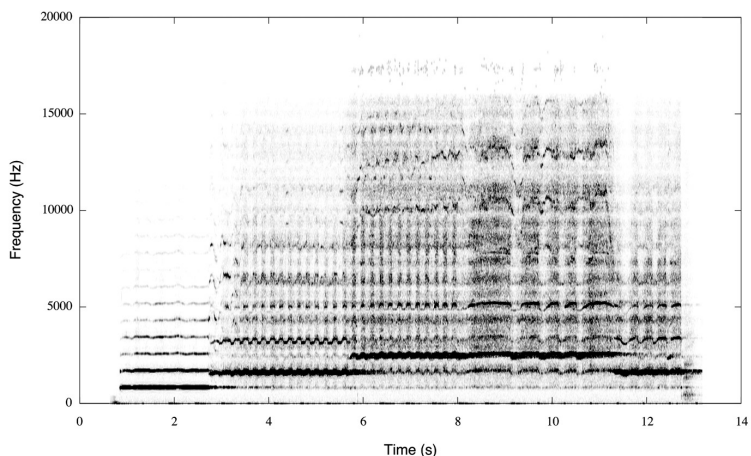


Fig 6. Sonogram showing the sound frequencies produced by playing the Antrea type model as a lip duct flute. Recording: Åke Egevad.

mouth, it took some time to position the lip or tongue correctly but success was eventually possible (Fig. 5). A high flute-like tone with the fundamental at 830–870 Hz was produced.³⁰ By blowing harder, it was possible to produce two even higher tones at 1582–1676 Hz and 2427–2596 Hz, respectively (Fig. 6). According to the spectrum analysis, all three tones had a more or less harmonic structure.

However, despite these promising results, it started to seem possible that the maker of the Antrea artefact did not intend to produce a lip or tongue duct flute. According to Mannermaa's³¹ observations, no traces of working can be seen around the hole, the suggested window, on the original artefact. There are no manufacture marks visible around the hole that suggest it was made intentionally. The edges in this area turn inwards, similar to the edges of the longitudinal crack that runs down the dorsal side through the hole. The blow resulting in the breakage may have struck the surface here, in the area of the hole. Moreover, a similar crack with a transverse hole-like section emerged when one of the type models was tested as a fisherman's tool (see below). The fracture by the crack is dry, indicating that the breakage took place sometime after preparation of the artefact.

TESTING THE ARTEFACT AS A REED PIPE

The U-shaped notch at the worked end of the Antrea artefact is also reminiscent of the blowing end of a reed pipe. Similar notches, which provide a base

for attaching the reed, are common in heteroglot reed pipes and clarinets. In traditional Finnish specimens, the reed was usually made of a strip of birch bark, a material that was easily accessible.³² One Upper Paleolithic bone tube, a bird radius from Hohle Fels in southwestern Germany, also has a similar notch.³³ When provided with a reed, this artefact works perfectly as a reed pipe.³⁴ According Jean-Loup Ringot,³⁵ an instrument similar to this one is easier to play than most flutes and can even be tuned by changing the size of the reed. Thus, many Upper Paleolithic bone tubes with finger hole-like openings actually may have been reed pipes, not flutes.

Inspired by these experiments, the Antrea artefact was also tested as a reed pipe. A piece of birch bark was cut to perfectly cover the notch of a swan bone copy and tied in its place with synthetic sinew (Fig. 7a–b). Birch bark appeared to be excellent raw material for reed making because it is flexible and not subject to change when put into the mouth and becoming wet. However, one problem occurred. As the tip of the worked end is cut off transversely, a flat semi-circular gap appeared between the reed and the tip of the blowing end (Fig. 7c). This gap prevented the reed from vibrating as necessary to produce sound. Our solution at the time was to close the gap with a piece of wax.

The finished copies and type models all performed well, producing a clarinet-like tone with harmonic structure and a fundamental at 330–400 Hz. The sound was lower and clearly louder than in the duct flute version. By cupping and un-cupping hands around the opening of the farther end, it was

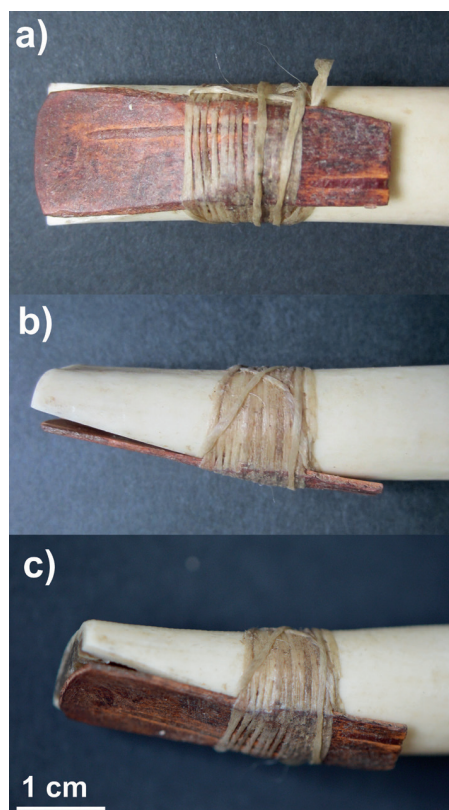


Fig 7. Reed pipe version of the Antrea artefact: a) the birch bark reed from the front, b) the birch bark reed in profile, c) the gap between the reed and the tip of the blowing end closed with wax. Photos: Riitta Rainio.

also possible to create quacking duck-like sounds. These might be useful if the artefact was used to lure water birds similar to certain reed pipes from nineteenth–twentieth century Finland.³⁶ This type of instrument without finger holes could also be used as a tool for making noise, or it could be an unfinished product, broken and discarded before the finger holes were carved.

The experiment demonstrates that this type of bevelled swan bone can be turned into a reed pipe. However, it does not prove that the Antrea artefact was used as this type of instrument. On the contrary, the test raised serious doubt. If the maker did have a reed pipe in mind, it would have been more logical and straightforward to cut the blowing end, not transversely, but obliquely all the way around so that the tip was pointed in profile (cf. Fig. 4b, 7c). Such a cut or notch would have provided a perfect base for the reed, removing the need for wax (or pitch) stuffing. That is to say, even if we sometimes open beer bottles with a screwdriver, that still does not prove that screwdrivers were invented to open beer bottles.

TESTING THE ARTEFACT AS A FISHERMAN'S MULTIPURPOSE TOOL

A reconstruction of the Antrea net at the National Museum of Finland immediately clarifies that these are pieces of a fishing kit. Was the worked swan bone perhaps some type of tool used to make or repair the fishing equipment? In the past, nets were made of sinews or vegetable cord; in this case, willow bast was the material.³⁷ The floats of the net were made of shield bark from pinus (*Pinus sylvestis*). Was the Antrea artefact a tool for peeling bark? To test this possibility, type models of goose and swan bone were used to strip bark of willow and red dogwood (*Cornus sericea*) twigs. When the bark was peeled with the curve of the U-shaped notch, the bark clogged up in the cavity and was no longer useful. However, when using the straight and transversely cut edge, it was easy to peel off narrow and even ribbons of bark (Fig. 8a). The corners of the edge helped to keep the bone tool in an even direction, and the corners did not cut into the twigs because they were rounded off. This peeling process left visible traces on the tool's edge, which gradually became thinner and sharper and finally slightly concave in form.³⁸ Somewhat similar edge characteristics can be found on the original Antrea artefact (cf. Fig. 4a, d). This process did not generate any wear at all in the curve of the notch, whereas a slight depression can be seen in this location on the original artefact (cf. Fig. 4c). This depression obviously developed by the object being rubbed along some solid or hard material.

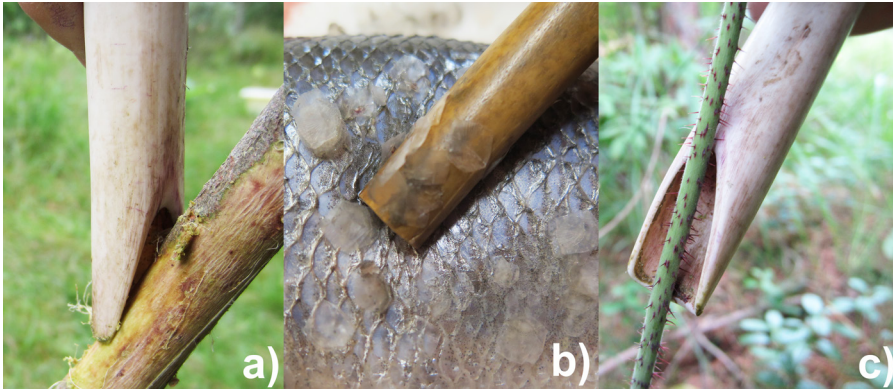


Fig 8. Type model of the Antrea artefact used as a fisherman's multipurpose tool: a) peeling strips of bark from willow (*Salix sp.*) twigs, b) scaling a sea bass (*Dicentrarchus labrax*), c) removing thorns from raspberry (*Rubus idaeus*) stems. Photos: Floris Grijp and Riitta Rainio.

Another possibility that occurred to us was that the Antrea artefact was used to scale fish when the fisherman wanted to consume a fish from the day's catch. The type models of goose and swan bone were used for scaling several sea bass (*Dicentrarchus labrax*) and powans (*Coregonus lavaretus*). The tool served this purpose extremely well. Scales were removed easily and fast without scattering them as happens when using a knife or one of the usual scaler tool types (Fig. 8b). This quality of the tool would be an advantage if a fisherman needed to scale fish in his boat. The rounded corners of the straight edge do not cut the fish skin. Keeping the skin intact is important if the skin is intended to be used as fish leather. It appeared to be necessary to empty the cavity of the bone type model by shaking or rinsing it regularly when the scales clogged it. When scaling large fish in succession, the goose bone cracked because too many scales accumulated and pushed the bone walls apart. Halfway down the diaphysis, the crack changed direction in a straight angle and then continued again longitudinally. The edges of the transverse crack even became chipped. The crack on the Antrea bone also runs at a straight angle. Was the transverse crack on this artefact chipped as well, and did the chipped edge become worn post-depositionally by contact with the ground thus creating a slightly wider opening suggesting a man-made hole?

In all, twelve large fish were scaled with the goose bone type model. In the process, more traces of wear became visible to the naked eye. These use wear traces consisted of deep scratches, furrows and a sharp edge caused by the hard and sharp scales. In addition, scaling seems to produce a flat plane in the curve of the notch, not a slight depression as is seen on the Antrea artefact (cf. Fig. 4c). If this artefact was ever used as a scaler, it certainly was also

used on another material that created the depression. Was the Antrea artefact perhaps not used on the outside of fish but on the inside as a flesher when making fish leather? The shape of the worked end is indeed reminiscent of a particular type of end flesher used by some Native American groups, including the Inuit and the Samis.³⁹ These tools are made of sturdy cannon bones of hoofed animals and are held at a right angle, more or less, to scrape large skins. The Antrea artefact is more effective for de-fleshing work when used obliquely. The fat to be scraped off fish skin would probably not cause deep scratches or a sharp edge.

However, another possible use of this object is as a tool for working tying materials when fishing equipment needed to be repaired. Rough stems of blackberry (*Rubus* sp.) and nettle (*Urtica* sp.) are traditionally used for this purpose, but their thorns or stinging leaves must be removed before use. Removing thorns is traditionally carried out using a bone or stone with a hole through which the stem is pulled. Conversely, nettle leaves are removed by hand, from the root upwards. A tool in the shape of the Antrea find would not seem to be the first choice for such work but also cannot be excluded. The use of this type was tested with nettles and thorny raspberry (*Rubus idaeus*) stems and also found to be conceivable (Fig. 8c). The use wear produced a slight depression both to the edge of the artefact and to the curve of the notch, thus resembling details seen in the original Antrea artefact. Considering the tasks described above, this type of bone tool may have been used (or misused) as a multipurpose tool in more than one way on different materials such as twigs, fish and stems.

INVESTIGATING THE ORIGINAL ARTEFACT WITH A STEREOMICROSCOPE

After all these experiments, the worked swan bone of Antrea was reinvestigated with a stereomicroscope (Leica MS5 x 6.3-40) at the National Museum of Finland. In general, the surface of the artefact is worn and abraded. Natural shine appears in some areas, but the bone surface is mostly matte. Erosion/grinding spots are visible in various parts of the surface, and only a limited part of the surface is unflawed. The worked area on the distal end of the bone is flat and smooth (Fig. 4a–c). The transversely cut edge seems to be thinner and sharper than the other parts of the worked area (Fig. 4d). Any striations, furrows or grooves appearing to be use wear marks are not visible on the worked area of the artefact.

DISCUSSION

Based on the experiments described above, the copies and type models of the Antrea artefact can be used for sound production. The flute and reed pipe versions of the artefact both perform well, producing flute- and clarinet-like tones with harmonic structure. The fundamental frequency of the versions moves approximately 830–870 and 330–400 Hz, respectively. The copies were played relatively easily and produced from organic materials available in Mesolithic Finland. Both instrument types also seem to have ancient roots in Europe. Archaeological examples of probable heteroglot reed pipes can be securely dated back to the Upper Paleolithic,⁴⁰ whereas the earliest possible known examples of lip or tongue duct flutes date from the Neolithic and the Middle Ages.⁴¹ Similar flutes and pipes without any finger holes were also found in nineteenth–twentieth century Finland and used, for example, for luring ducks and driving off beasts. The tube in these ethnographic examples was usually made from bark.⁴²

Nevertheless, both instrumental interpretations of the Antrea artefact become less plausible or less convincing due to small structural details and discrepancies. For making a heteroglot reed pipe, it would have been more logical and straightforward to cut the tip of the blowing end, not transversely, but obliquely all the way around, so that the tip was pointed in profile. This type of cut or notch would have provided a perfect base for the vibrating reed, obviating the need for any wax (or pitch) filling material. Conversely, making a lip or tongue duct flute would have been required carving a hole in the opposite side of the U-shaped notch, but the hole in the Antrea artefact appears more likely to have been produced accidentally. No manufacture is present suggesting the hole was produced intentionally. Thus, despite the playability of the copies, it is quite possible that the maker of the artefact did not have a reed pipe or a lip or tongue duct flute in mind when manufacturing this object. As the U-shaped notch is also unsuitable for the blowing end of an end-blown flute,⁴³ the artefact is most likely not a wind instrument or sound instrument at all.

After weighing out all possible voicing methods and eliminating the sound tool hypothesis, we did not have to begin again. During the experiments, several alternative explanations surfaced for the ways such a tubular artefact with a notch might have functioned. The find context of the artefact, the fishing net woven from willow bast, suggested that it would be reasonable to test the copies as being among a fisherman's or net maker's bevel-ended tools. The artefact works effectively as a fish scaler and bark peeler, such as for peeling willow twigs. It also works as a tool for removing thorns and

stinging leaves from potential tying materials. Furthermore, the artefact resembles so-called bone flesher, which some Native Americans, including the Inuit, used for de-fleshing and scraping animal hides.⁴⁴ The processes of peeling, scaling and de-thorning all abrade the transversely cut edge of the artefact, making it gradually thinner and sharper. The process of peeling with the most intensive abrasion pressure, turns the straight edge slightly concave in form. Close study with a microscope demonstrated that the worked area of the original Antrea artefact has been turned into a smooth, flat and slightly irregular surface. Our impression is that any use wear marks that were present have all been abraded away during the time of deposition in the clay bottom sediments. After this second sight, we argue that the potential light striations, mentioned earlier by Mannermaa,⁴⁵ seem to be natural structures of the bone. However, the thin and sharp edge of the original artefact may indicate that this part has been subjected to more intensive abrasion than the other parts (sides and the notch) of the worked area. Our experiment revealed that the particularly intensive abrasion pressure involved in bark-peeling makes a similar thin and sharp edge.

After all this scrutiny, the Antrea bone still remains something of a mystery artefact. In shape, it is reminiscent of several ethnographically known instruments and tools, but it does not seamlessly fit any of these potential functions. One possible reason for this formal discrepancy could be that the artefact was some type of general multipurpose tool or even an unfinished product, cracked or otherwise lost before its completion. The latter possibility could be supported by the find context, which contains a collection of more than ten swan bones, several of them with abrasion or gnawing marks on their surface.⁴⁶ Of these swan bones, the studied artefact is the only one that is clearly worked. The impression is that just before the fishing kit was accidentally lost in the waters of Ancylus Lake, a whooper swan had been caught, cut up and consumed, possibly by sucking marrow out of the bones. One humerus, however, had proceeded from food refuse scraps and raw material to the phase of further processing.

CONCLUSIONS

Various experiments with the copies of the worked swan bone of the Antrea net find have demonstrated that the artefact probably was not a sound instrument, either a flute or a reed pipe. After trying out all possible voicing methods, it appears that the wind instrument hypothesis can be abandoned. More probable uses for this type of artefact would be as bevel-ended tools

used in scaling fish, peeling bark and/or making or repairing nets. Although the Antrea bone does not display any scratches or furrows, some wear marks are visible on tools in our scaling and peeling experiments, even with the naked eye. Earlier experiments indicate that microscopic marks are also created during such processes.⁴⁷ Such sophisticated marks are also not visible in the Antrea find, possibly only because they have been abraded away in the ground following the object's deposition in the lake sediment. However, the thinning and sharpening of the edge on the original artefact may indicate similar contact and use as our experiment specimen after peeling willow branches.

Acknowledgements

Chair of Archaeology at the University of Helsinki is thanked for supporting the writing of this article.

NOTES

- ¹ Pälsi 1920; Luho 1967.
- ² E.g., Suomusjärvi type transverse axe, gouge and fragments of chisels. Pälsi 1920; Luho 1967, 25–31; Carpelan 2008.
- ³ Luho 1967; Carpelan 1999, 161; Miettinen et al. 2008.
- ⁴ The sound connecting Lake Ladoga with the Baltic.
- ⁵ Pälsi 1920, 10; Carpelan 1999, 161.
- ⁶ Miettinen et al. 2008; Carpelan 2008.
- ⁷ Winge, unpubl.
- ⁸ Pälsi 1920; Äyräpää 1950; Carpelan 2008.
- ⁹ Mannermaa & Ukkonen 2002, unpubl. table 1.
- ¹⁰ Luho 1967, 29.
- ¹¹ Lund 1981b, 259.
- ¹² Leisiö 1983, 547–548.
- ¹³ Mannermaa 2005.
- ¹⁴ Mannermaa 2005, 76–77, Fig. 4.
- ¹⁵ Mannermaa 2005.
- ¹⁶ The sound samples were recorded using two Neumann KM 183 condenser microphones and analysed with the Spectutils sound analysis and visualization software toolkit, see Lassfolk & Uimonen 2008.
- ¹⁷ Lund 1979; Leisiö 1983, 153, 547; Mazurkevich et al. 2012, Fig. 2.39.
- ¹⁸ Buisson 1994; Münzel et al. 2002; Conard et al. 2009; Higham et al. 2012.

- ¹⁹ Organology = the study of musical instruments.
- ²⁰ Münzel et al. 2002; Morley 2006, 62.
- ²¹ Idioglottal reed = a tongue cut in the wall of the reed tube itself.
- ²² Heteroglottal reed = a separate strip is mounted on an opening in the reed tube, intermittently closing it.
- ²³ Yet another possible voicing method would be: 4) blowing air through puckered lips that are placed against the tube end (trumpets). However, this method is excluded from this testing because it is obvious that the deep notch at the open end prevents the Antrea artefact from being played in this way.
- ²⁴ Seeberger 1998; Lawson & d'Errico 2002; Ringot 2012; Wyatt 2012.
- ²⁵ Mannermaa 2005.
- ²⁶ Leisiö 1983.
- ²⁷ Leisiö 1983, 96–107
- ²⁸ Lund 1981a.
- ²⁹ Lund pers. comm., 21 Nov. 2014.
- ³⁰ The measured frequencies are only suggestive because the farther end of the type model is slightly different from that of the original artefact: in the type model the epiphysis is removed, in the original artefact it is present.
- ³¹ Mannermaa 2005, 76.
- ³² Leisiö 1983, 231, 236, 238, 244.
- ³³ Conard et al. 2009.
- ³⁴ Ringot 2012.
- ³⁵ Ringot 2012.
- ³⁶ Leisiö 1983, 167–168.
- ³⁷ When making cord from willow, the bark itself is not used but the inner layer called the cambium. This layer is separated from the bark.
- ³⁸ Experimental work combined with high magnification examinations of bark peelers has been carried out by Maigrot 2003 and Legrand 2005, for example.
- ³⁹ Flesher...; Hide Scraper...; Hide Tanning...; Murdoch 1892, Fig. 299; Rahme 2014, 49.
- ⁴⁰ Ringot 2012; Wyatt 2012; cf. also Emsheimer & Lund 1983.
- ⁴¹ Lund 1981a; Lund pers. comm., 21 Nov. 2014.
- ⁴² Leisiö 1983, 96–107, 163–168, 235–236, cf. also Emsheimer 1981.
- ⁴³ Mannermaa 2005, 76.
- ⁴⁴ Flesher...; Hide Scraper...; Hide Tanning...; Murdoch 1892, Fig. 299; Rahme 2014, 49.
- ⁴⁵ Mannermaa 2005.
- ⁴⁶ Pälsi 1920, 11, 14; Mannermaa 2005, 76.
- ⁴⁷ Maigrot 2003, 136–139; Legrand 2005, 93–94.

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