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Reviewed Article:

Early Medieval Bone Pipes: Understanding the Sounds of These Instruments through Reconstruction

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Bone pipes are the most numerous instrument surviving from Early Medieval England. These instruments are usually classified as 'flutes' despite many of the examples missing the defining categorisations. Two examples from the archaeological record of early Medieval England will be used as case studies: one instrument from North-West Essex and the other from York. Through recreating these instruments as both reed pipes and flutes, it will be demonstrated how they could have been sounded by either mechanism. Additional

experimentation will demonstrate an understanding of what type of sounding mechanisms were more likely and features of the bone pipes, such as holes for hanging the instruments from. These experiments will also show the distances over which the sound of the different mechanisms may have travelled and the way the features of the bone impacted on the results.

> The different shafts and shapes of bone, including orientation had an impact on the type and level of sound produced from the pipe. If a loud sound was required, it is possible natural features such as the opening out of a tibia were used to act as a natural bell.

Introduction

Bone pipes dating from both the early and late medieval period have been found in the archaeological record from across central and Northern Europe such as in: The Netherlands (Tamboer, 2004), Denmark, Sweden (Lund, 1981a), Poland (Poplawska, 1998), Latvia (Urtan, 1970) and Estonia (Oras, 2015) (Tamboer and Rainio, 2020). One of the first comprehensive studies of these instruments as a whole is that by Brade, published in 1975. Bone pipes are among the most common sound-producing artefacts found in the archaeological record of Early Medieval England and have been comprehensively catalogued in Leaf's 2008 PhD thesis (Leaf, 2008). This work assessed the archaeological contexts and physical aspects of the bone pipes, including bone type. Leaf generally designates these bone pipes as 'flutes', and states that bone flutes are duct flues (Leaf, 2008, p.28). Researchers such as Graeme Lawson, have previously suggested some of the finds designated in her thesis as flutes, such as one from Winchester, Hampshire, may have been reed pipes (Lawson, 2009, p.524). Lawson also suggests reed pipes were more likely to have been made from metapodials, potentially with horns added, while flutes were usually made of: Ovicaprid tibia or swan, crane, or goose ulna (Lawson, 2009, p.524). Mammal, such as ovicaprid, metapodials used for reed pipes have also been identified in research by Annemies Tamboer and Riitta Rainio (2020). In both these publications, it was suggested chamfering at the end may have been due to inserting the pipe into a hollow terminal such as a horn, potentially secured in place with a material such as beeswax, for use as a hornpipe or bagpipe chanter (Lawson, 2009, p.524; Tamboer and Rainio, 2020, p.120).

The categorisation of these bone pipes as flutes, even when distinguishing characteristics are missing, is often seen in the archaeological site reports. For example, one of the bone pipes found at Flaxengate, Lincoln has a clear window, making it a definite duct flute, but this instrument was separated from the other so-called 'flutes' and called 'some kind of flute' while bone pipes of uncertain categorisation were placed under a definite heading of 'bone flutes' (Mann, 1982, p.16). Even in Brade's catalogue, subsequent researchers, such as Megaw, noted that she overlooked the possibility of her 'duct flutes' being end-blown/non-duct flutes or phalange whistles, exemplifying the problems encountered when looking at bone pipes

(Megaw, 2015, pp.10-11). This is also a problem with museum collections. Generally, bone pipes are designated as flutes with a few rare exceptions such as a pair of reed pipes from Ipswich which, due to their completeness and no window present, have been catalogued as reed pipes. This article will reassess some of the bone pipes from the Early Medieval period focusing on two contrasting case studies: one which was found at Coppergate, York, and one which was found at Wicken Bonhunt, North-West Essex. By experimenting with recreations of these objects as both reed pipes and flutes, an assessment will be made of whether the bone pipes that have previously been categorised as bone flutes, but which lack distinguishing characteristics could have also been voiced as reed pipes. The impacts of the different sounding mechanisms will also be assessed. The artefacts discussed here are made from bone, but such objects could also have been made of materials such as wood which decays more readily than bone and may therefore have been lost to the archaeological record if they existed.

The different sounding mechanisms, and sometimes ambiguous nature of the finds, means different terms are required, and used, in this paper to designate the objects:

Pipe	An instrument consisting of a tube which could be voiced in a variety of ways including as a flute or reed pipe. In this paper, the term 'bone pipe' will be used unless the pipe can be more narrowly categorised. The overall category for these instruments, as designated by Hornbostel and Sachs (revised), is aerophones and often to class an object with certainty beyond this general classification, when it is based on interpretation, will lead to misunderstanding and confusion (Wyatt and Benito, 2016, pp.198-199).
Flute	An instrument that produces the sound by air flowing over an opening. Different types of flutes exist, including duct flutes where the air is forced over a window[1] using the tongue or a duct/fipple, and flutes where the air is blown across an opening and hits the opposite side (either end-blown or transverse). Panpipes and whistles are also voiced in a flute style method.
Reed pipe	an instrument usually comprising a tube and voiced by a reed attached to the proximal end of the pipe.
Lip-vibrated pipe	an instrument comprising a tube which is sounded by vibrating the lips in a similar manner to how modern brass instruments are played. This type of pipe will not form the focus of this article, but it is important to be aware of other possible methods of sounding such pipes.

One aspect which can be used to identify a duct flute is the presence of a window or fipple. However, fipples/blocks have rarely survived in the archaeological record due to them being made of organic materials (Dallas, 1993, p.159). Tongue-duct flutes were also possibly used in both the ancient and medieval periods and would consequently not have had a fipple/block (Lund, 1981b, pp.108-109). These instruments are considered to have been relatively widespread, having been found in places such as Greece and the Soviet Union (Emsheimer, 1981, pp.103-105). Consequently, even if an instrument is found with no hint of duct/fipple,

categorisation as a duct flute must not be discounted. The presence of a window, often designated as an opening on the side of the top end of the bone pipe with a ramp leading into it, can identify an object as a duct flute. If the pipe shows signs of having been finished at both ends with no clear window, the object could not have been used as a duct flute. How finished the ends are is sometimes ambiguous. The part of the pipe containing the window may have been lost, or the window confused for a fingerhole (See Figure 1), or vice versa, meaning the lack of a window is not enough to say the bone pipe was not a duct flute. While finished, rounded ends may mean the pipe was more likely to have been a reed pipe or lip-vibrated pipe, the lack of a fine-edge does not discount the pipe working as an end-blown pipe (See Figure 1). Previous experimentation has shown that while pipes without a fine-edge can be played as an end-blown flute, they require a higher air pressure and do not allow for lower fundamentals to be sounded compared to when an end-blown flute is played with a fine-edge (Wyatt, 2012, pp.393-394). These illustrate the potential problems and why a careful examination of any finds is essential. The proposal of function of the pipe beyond use as an aerophone is interpretation and should therefore be treated with caution (Lawson, 1981, p. 31).

Forty-one bone pipes dating from Early Medieval England have been discovered to date. These artefacts all share the common feature that they consist of one or more pipes with either no additional parts or just the addition of a voicing mechanism. Despite these instruments often being designated as bone flutes, generally referring to duct flutes, especially in the archaeological assemblage site reports, only 18 out of the 45 (40 %) bone pipes dated to Early Medieval England (or just after) are definitely duct flutes due to the presence of a window (See Figure 2). Four (9 %) of the bone pipes were almost certainly reed pipes. Given the lack of windows, or evidence for such a feature, on the other 27 bone pipes, they should not be classified as duct flutes, and potentially represent bone pipes voiced using a different method. The different methods of voicing bone pipes would have added diverse sounds to the environment of Early Medieval England. Through recreating two examples of bone pipes of unknown type as both duct flutes and reed pipes, and testing these in various environments it will be demonstrated whether such objects had the potential to be sounded as reed pipes and/or flutes. It is also possible the unknown bone pipes were sounded as end-blown flutes or lip-vibrated pipes, but the current lack of evidence for such in Early Medieval England means the instruments have not been recreated as this. The main aim of this experimental reconstruction is to show the contrasting sounding mechanisms and consequently, a flute-style mechanism and a reed mechanism are sufficient for such an experiment. There is an example of a set of wooden panpipes, dated to 866–1066, from Anglo-Scandinavian York (Morris, 2000, pp.2353-2354). These panpipes were end-blown, and recreations of them show that the sound, especially when compared to contrasting reed pipes, was similar to that of instruments with a duct-type mechanisms (See Recording 1).

Case studies

For this experiment, two contrasting archaeological bone pipe specimens were chosen: One from a rural settlement (Wicken Bonhunt) and the other from an urban settlement (Anglo-Scandinavian York). These instruments were made from morphologically contrasting bones – the Wicken Bonhunt instrument is made from a mammal bone (ovicaprid tibia) and the Anglo-Scandinavian York example from a bird bone (swan ulna). The contrasting examples allowed for research into whether types of bones were better suited to one purpose than the other. These bones have different shaft shapes, and the effect this has on acoustical properties will be shown in this experiment. Only the fingerhole end of these bone pipes remains, and they lack any distinguishing characteristics such as a window, leaving the type of pipe these objects were open to debate.

Case study one

The instrument from Wicken Bonhunt, dated to AD 1000–1100, was found at a site which was a demesne farm, consisting of one building, four long plots, and an enclosure (Bradley and Hooper, 1974; Wade, 1980; Leaf, 2008, p.419). Made from an ovicaprid tibia, all that remains of this bone pipe is the distal end featuring 3.5 fingerholes (See Figures 3 and 4). There is a further hole on the side of the instrument which is now broken through to the end (See Figures 3 and 4). Whether the break occurred during use or after deposition is unknown. The use of this hole is unclear; it may have been for hanging the instrument from a piece of string to attach to a person's being, such as around their neck, while going about their daily activities. The panpipes from York feature a hole from which it is believed the instrument was hung (Morris, 2000, p.2353). The hole on the broken instrument may have been worn and broken due to the string rubbing against it. Further analysis under a microscope, may prove if such is the case, and consequently suggest how much the object was used as was possible on a bone pipe from Isituritz (Benito, Alcolea and Mazo, 2016). There is no evidence remaining for a sounding mechanism on the Wicken Bonhunt pipe: no presence of a window or end having been specifically shaped for a reed or to have been end-blown. It is possible a reed could have been inserted into the remaining end, or the evidence for the sounding mechanism could be on the missing portion of the bone pipe. For the bone pipe to have played as a duct flute a window would have been required. Unlike the other types of sounding mechanisms, this window requires a portion of bone for its creation. An examination of whether there would have been enough space on the length of bone that is missing from the fragment for the creation of a window can be used to determine if the pipe could have been sounded as a duct flute. If there is enough space on the bone it does not mean the instrument was a duct flute, but merely that the instrument could have been a duct flute. The fragment of bone that remains is 65 mm long and 15 mm wide at the widest point (the end) (see Figure 3). An average sheep tibia measures 195 mm long. Allowing for the ends of the bone to have been removed to leave a hollow shaft, there is ample difference between 195 mm and 65 mm to have allowed for a window, so the object could originally have been sounded as any of the mechanisms mentioned above.

Case study Two

A bone pipe found at Clifford Street, York, dated to AD 975–1100, as with the Wicken Bonhunt instrument, does not have any clear sign of what the sounding mechanism was, despite being designated as a bone flute (See Figures 5 and 6). The Clifford Street bone pipe, in contrast to the Wicken Bonhunt instrument, was found in an urban site, in what was the major Anglo-Scandinavian trading centre of York, with associated finds such as: Combs, pins, and tools which potentially suggest the objects were from a nearby workshop (Leaf, 2008, p.449). However, the smooth patina of the surface of the instrument suggests it was much used before deposition (Leaf, 2008, p.449). The remaining fragment features three fingerholes. The distance to both ends is greater than that between the fingerholes, potentially indicating there were no further fingerholes. Examples of bone pipes have been found with a large gap between the end of the bone pipe/the window and the fingerholes. Alternatively, there could have been another set of fingerholes away from the remaining set, separated because they were meant for the other hand. The lack of any other examples with this pattern may dispute such a possibility. This instrument was recreated with just the tree fingerholes as on the surviving fragment. The fragment that remains is 117 mm long and 12 mm wide and was suggested to have been from an extremely large swan (See Figure 5) (Leaf, 2008, p.449). Considering the same idea as with the ovicaprid tibia above, an average swan ulna can be looked at to see if it would have allowed for a window. Given the original was from an extra-large swan, the length could have been even longer. The average swan ulna is 282.5 mm long and therefore there would have been space in the remaining length of bone for a window, but the instrument could equally have been sounded by another type of mechanism.

Recreating the instruments

The bones of swan ulna and sheep tibia were sought to make the recreations. While one end of both the bone pipes is complete, the other is not and it is not currently possible to know how much more of the bone would have been used to create the original. As a result, it was decided to make the bone pipes the maximum length the bone would allow. Therefore, the proximal end was cut just at the point where the shaft of the bone began. Although the length of the bone above the fingerholes determines if there is enough space for a window, the amount missing would not have greatly impacted whether a certain sounding mechanism worked, unless there was not enough space for a window, so it was decided to use as much of the bone as possible. The fingerholes were created using a knife, which was probably the original tool used. The number of fingerholes placed on the recreations was the same as on the archaeological specimens. However, there may have been further fingerholes on the original complete specimens.

The sounding mechanisms were then created for the bone pipes: a reed sounding mechanism and a flute sounding mechanism – representing the two main types of sounding mechanism present on the bone pipes so far discovered from Early Medieval England. For the

reed mechanism, it was decided to make a single reed from *Phragmites australis*. This type of reed is still used on the modern Welsh pibgorn (a folk instrument of a hornpipe-style similar to those found at some Early Medieval Scandinavian and English sites) and was probably used during the Early Medieval period (Harper, 2007, pp.1-6; KilBride, 2021). This plant is native to the UK and would have been commonly available at the time from which the bone pipes date. The reed would have been relatively quick to create. These reeds (See Figure 7) are created by taking a length of reed, preferably with a node at one end, although this could always be achieved by using beeswax, and cutting a slit on one side which is gradated at the top and sanded down. It is this tongue which, when blown, vibrates back and forth producing the oscillations and therefore sound. The addition of some beeswax may have been necessary to secure the reed in place. Beeswax would also allow for easy removal of the reed if the reed required work or replacement. While this was the reed chosen, it should be noted that a reed made from a feather quill, such as that of a swan, or elder could equally have been used. Additionally, a double-reed made from two pieces of reed, as on the modern oboe, could have been created. These types of reeds all slot into the bone pipe in a similar way. Playing the pipes with swan feather reeds as opposed to *Phragmites australis* reeds was not found to make a significant difference to the results shown here. For the bone pipe from Wicken Bonhunt, it was found that the reed fitted most easily in the narrower end as otherwise something was required to hold it in place and fill the remaining gap at the end of the pipe (See Figure 8). This could be avoided by cutting the bone shorter so just the narrow part of the shaft remained, and the reed then placed in the other end from where the fingerholes are. With the bone pipe from York, on the other hand, the reed was placed in the end furthest from the fingerholes, but could equally have gone in the other end, which would have resulted in different pitches produced when the fingerholes were uncovered (See Figure 9).

To create the duct mechanism, a window had to be created. As with the fingerholes this was done using a knife. The window, particularly on the sheep tibia, was made with a small ramp leading into it: a feature seen on the mammal bone duct flutes from this period in England. The duct then had to be created. Wax, a material that would have been available in Early Medieval England, was used in this instance, although other substances could have been used such as wood, or the tongue for a tongue-duct flute. In terms of establishing the sounding mechanisms, the actual material was inconsequential. The duct for the recreations was created through melting wax and filling the end of the bone pipe up to the window. A slit was then made through the wax on the side where the window was to form a small gap where air could be blown and hit the window to sound the object. It was found the angle was relatively important to ensure the bone pipe sounded.

While both reed and duct mechanisms were relatively simple to create with objects commonly available at the time, a reed was perhaps the easier, as it only required a slit made in a piece of reed. In both examples, the duct was created at the opposite end of the bone

pipe from where the fingerholes were because the other end of the finds were complete and do not feature a window (See Figures 8 and 9).

Testing the recreations

The recreations based on the Wicken Bonhunt and York bone pipes sounded as both duct flutes and reed pipes and therefore could have been either (See Video below). Bone pipes with no distinguishing sounding mechanism should not immediately be categorised as duct flutes. To further understand these instruments, it was important to test the bone pipes in as close to the original environment as possible. To accomplish this, the instruments were recorded, and the distance over which the sound could be heard was measured in both an open environment and a woodland environment. A location was selected where sound pollution caused by industry today was minimised as much as possible to replicate the conditions of the Early Medieval world. The weather conditions were mainly sunny with some gusts of wind (between 17 and 21 degrees Celsius). It was decided to test in both an open area and woodland as these are two relatively different environments in terms of how the sound acts and would potentially give different results. The Wicken Bonhunt bone pipe was found in a demesne farm, with few other buildings around it. Therefore, the instrument being tested in such environments is particularly appropriate for this instrument, and if it is found to have carried over large distances, would suggest it could have been used for signalling while outside. The York instrument was from an urban environment but testing instruments in such an environment today is complicated because the level and composition of sound pollution is so different today in urban areas. Future research may be able to assess this further.

VIDEO1-8: SWAN ULNA DUCT FLUTE IN WOODLAND | SWAN ULNA DUCT FLUTE IN AN OPEN AREA | SWAN ULNA REED PIPE IN WOODLAND | SWAN ULNA REED PIPE IN AN OPEN AREA | SHEEP TIBIA DUCT FLUTE IN WOODLAND | SHEEP TIBIA DUCT FLUTE IN AN OPEN AREA | SHEEP TIBIA REED IN WOODLAND | SHEEP TIBIA REED PIPE IN AN OPEN AREA. ALL BY LUCY-ANNE TAYLOR

To measure the distance over which the instruments could be heard, one person stood in a carefully chosen position (See Figure 10) and played each instrument in turn. Two people (in this case female aged 24 and male aged 23) moved backwards to find the furthest distance at which they could still hear the instrument. The instruments were played loudly, as that should give the largest range of distance over which the sound travelled in the conditions on the day chosen, and with those listeners. Measurements were taken for both the highest and lowest notes of the instrument. To measure the distance over which the sound could travel a piece of string 100 m long was used with meters marked in black, and red and blue used to emphasise 5 m and 10 m respectively. A compass was used to ensure a constant direction was measured, northwest for the open area and southwest for the woodland area. The directions were chosen for accessibility. As the string was only 100 m long the instruments were all checked at this distance and those which could not be heard at 100 m were measured at the point where they became inaudible. The string was then moved on to the next 100 m, again using a compass, and so on. When the sound of the bone pipe could be heard over a distance greater than 250 m the distance was measured using GIS coordinates as beyond that distance a bog had to be navigated meaning coordinates were the easiest way to measure the distance. The measurements which were made using coordinates are shown with an asterisk. To allow for comparison both the distances over which a 23-year-old male human voice carried and reed carried were included.

The sound generally carried about the same distance or less far in the woodland area compared to the open area (See Figure 11). This may have been due to the wind being greater which caused more sound disturbance in the woodland than the open area as it became cloudier and stormier later in the day when the woodland data was collected. The sound of the bone pipes generally carried further, or about the same distance as the male voice. The instruments may have been used for signalling, as well as potentially entertainment, especially when distances were greater than that able to be covered by shouting. These instruments are relatively small which would have allowed them to have been easily carried on a person, perhaps further suggesting a use for signalling. Animals could potentially have heard the sound over the same distance, if not further, given some animals have a greater sensitivity to sound than humans (Heffner and Heffner, 2007, p.21). The instruments may also have been used for purposes to do with animal husbandry, such as rounding them up.

When played, the instrument must have had an impact on the environment and people around them, potentially being some of the furthest carrying manmade sounds of the day, although sounds such as thunder would have carried further. The effect these instruments

had on the world around them could have been quite prolific given their range of sounds and distance over which they could travel. Some of them could be played more quietly if that was required.

The bone pipe from Wicken Bonhunt features a hole on the side of the instrument (See Figures 3 and 4). Testing of this hole showed it worked as either an additional fingerhole or a hole to attach the instrument to a thread for carrying (See Figure 12). Given the four fingerholes on the remaining fragment of bone pipe, if this hole on the side was also a fingerhole, both hands would have been required to play the instrument (See Videos 5–8). Only requiring the extra hand for this one fingerhole suggests it was more likely that the hole was used for hanging the instrument. When a reed was added, it was much easier to place in this end, as the smaller shaft size held the reed in place. This also meant the natural opening out of the bone shaft at the wider end created a natural bell which amplified the sound. It is possible the bone was cut further away from the proximal end in which case the shaft would have been smaller, and the reed could have been placed in the opposite end to the fingerholes with a piece of string attached through the side hole. However, hanging the instrument from a piece of string would have meant the reed was at risk of falling out or being damaged. It should be noted that a reed could have been carried on a person and only attached to the instrument when it was played. The find site on a farm with little else around may support the suggestion that the pipe functioned as an easy-to-carry signalling instrument. These points suggest that the presence of the fifth hole supports the idea that this instrument was played as a flute rather than with a reed. In contrast, the instrument discovered in York was in an urban context. It may have been used as either a flute or reed-sounded instrument for entertainment because the sounds of the urban environment would have meant the sound of the instrument would potentially not have carried as far. The shaft shape does not allow for a natural bell to amplify the sound of this instrument.

The different shafts and shapes of bone, including orientation had an impact on the type and level of sound produced from the pipe. If a loud sound was required, it is possible natural features such as the opening out of a tibia were used to act as a natural bell. It is known bells, either built-in, as on an instrument which was found in York, or added, as on the hornpipes, were used at the time. When compared to the distance the reed on its own carried, the sheep tibia, with the natural bell can be seen to amplify the sound, meaning it carried further. There is also a difference between the distance the sound carried depending on the bone's features, such as shaft shape and size, and length of the instrument. It is possible the shape and size of the bone to make the instrument was considered depending on for what the instrument was going to be used, and if the distance over which the sound travelled was of consequence.

Conclusion

There are several bone pipes from Early Medieval England, which, despite previously being categorised as duct flutes may represent other types of bone pipes. The exact nature of these

is unknown and it has been demonstrated here that bone pipes that do not show the distinguishing characteristics such as a window should not immediately be classified as duct flutes and could have been reed pipes. It is also possible that bones other than metatarsals were used as reed pipes, as they have been proven to work as such in this paper. It must be noted that this paper is not stating these finds are not duct flutes but merely we should keep an open mind about the mechanism used to sound them. The sounds they made may have affected how these pipes were used. Playing the recreations and the experiment in the New Forest demonstrated the difference in sounds available from bone pipes sounded by different mechanisms. Both types of pipes could have been used for signalling due to the distance over which the sound travelled. The pitch of the pipes may have been higher if the length was shorter than the recreations. The instrument from a rural environment was potentially a flute, as the pipe could have been hung around a person's neck and easily carried without requiring an additional part. In urban areas perhaps the requirement to carry it with you and not have additional parts was not so important, so the instrument from York may have been used as a reed pipe or flute. Signalling in urban environments also may not have been as important, so perhaps this bone pipe represents an instrument used for entertainment. It has been proven that several of the objects previously categorised as bone flutes could have been sounded in either a flute-style way or using a reed and should not immediately be categorised as bone flutes unless distinguishing features, such as a window, are present.

1 The window is an opening on the side of the top end of a duct flute which has a ramp leading into it. When air, through the use of some kind of duct mechanism, is forced over the ramp of the window, the instrument is caused to sound.

Attachment(s)

Recording 1. Recreated panpipes based on the set from York (AD 866-1066). Done by Lucy-Anne Taylor (440.62 KB)

Keywords music & musical instruments
(re)construction

Country United Kingdom

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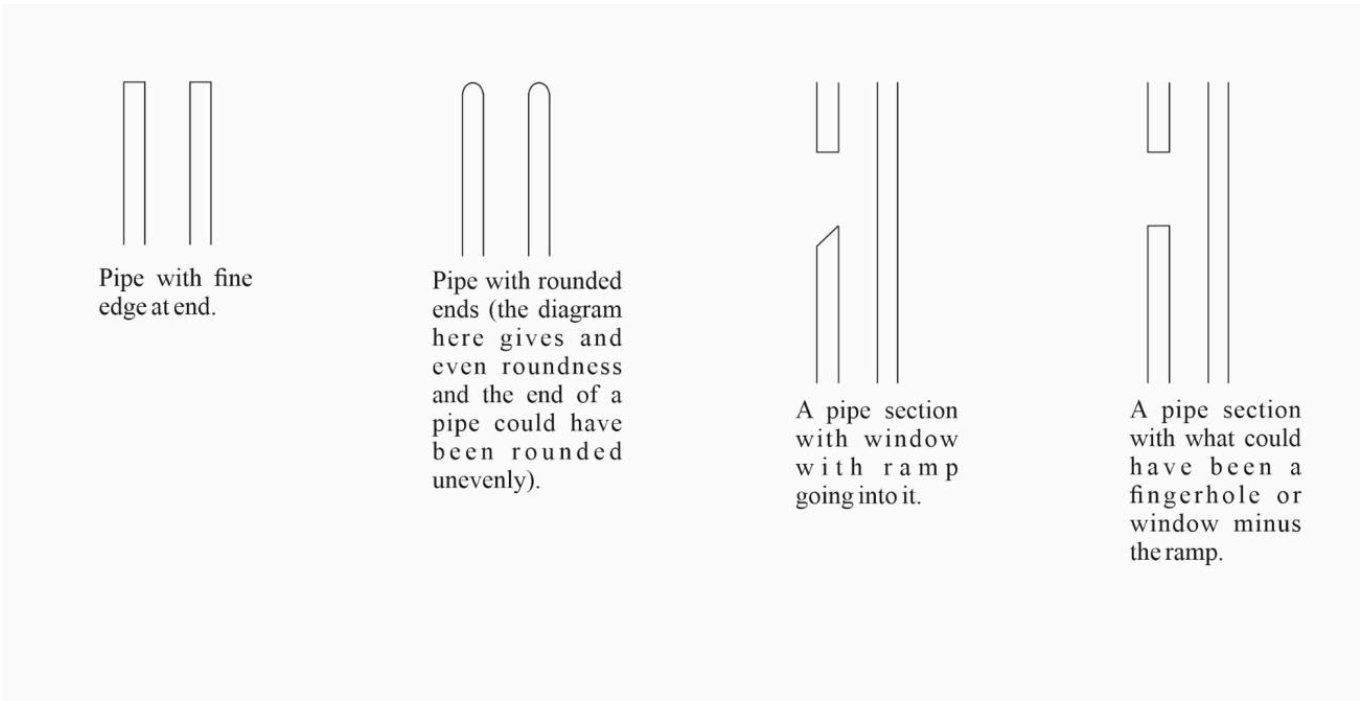

FIG 1. DIAGRAMS OF DIFFERENT ENDS AND OPENINGS OF BONE PIPES. DRAWING BY LUCY-ANNE TAYLOR

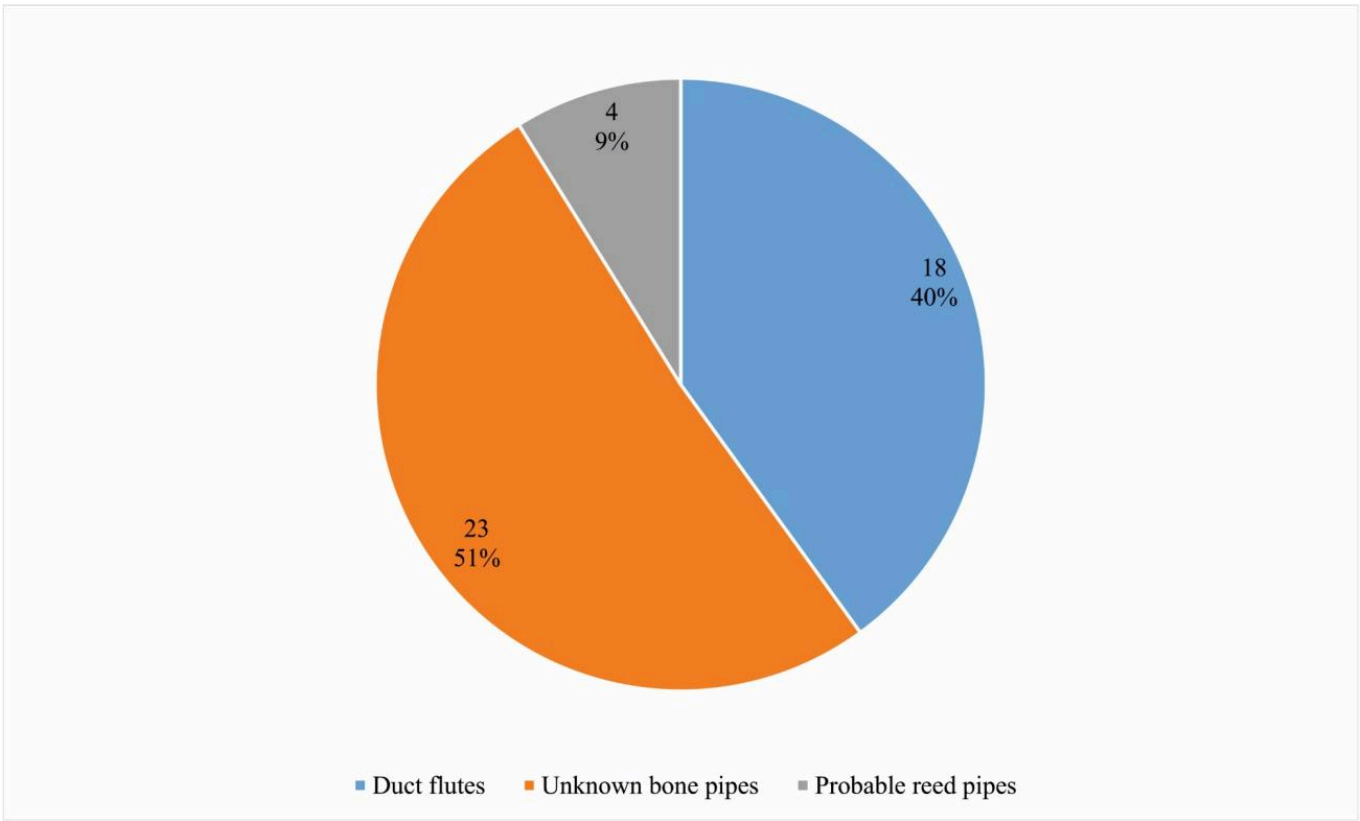

FIG 2. PIE CHART SHOWING THE NUMBER OF BONE PIPES WHICH ARE CLEARLY DUCT FLUTES, REED PIPES AND THOSE WHICH ARE UNCLEAR. DRAWING BY LUCY-ANNE TAYLOR

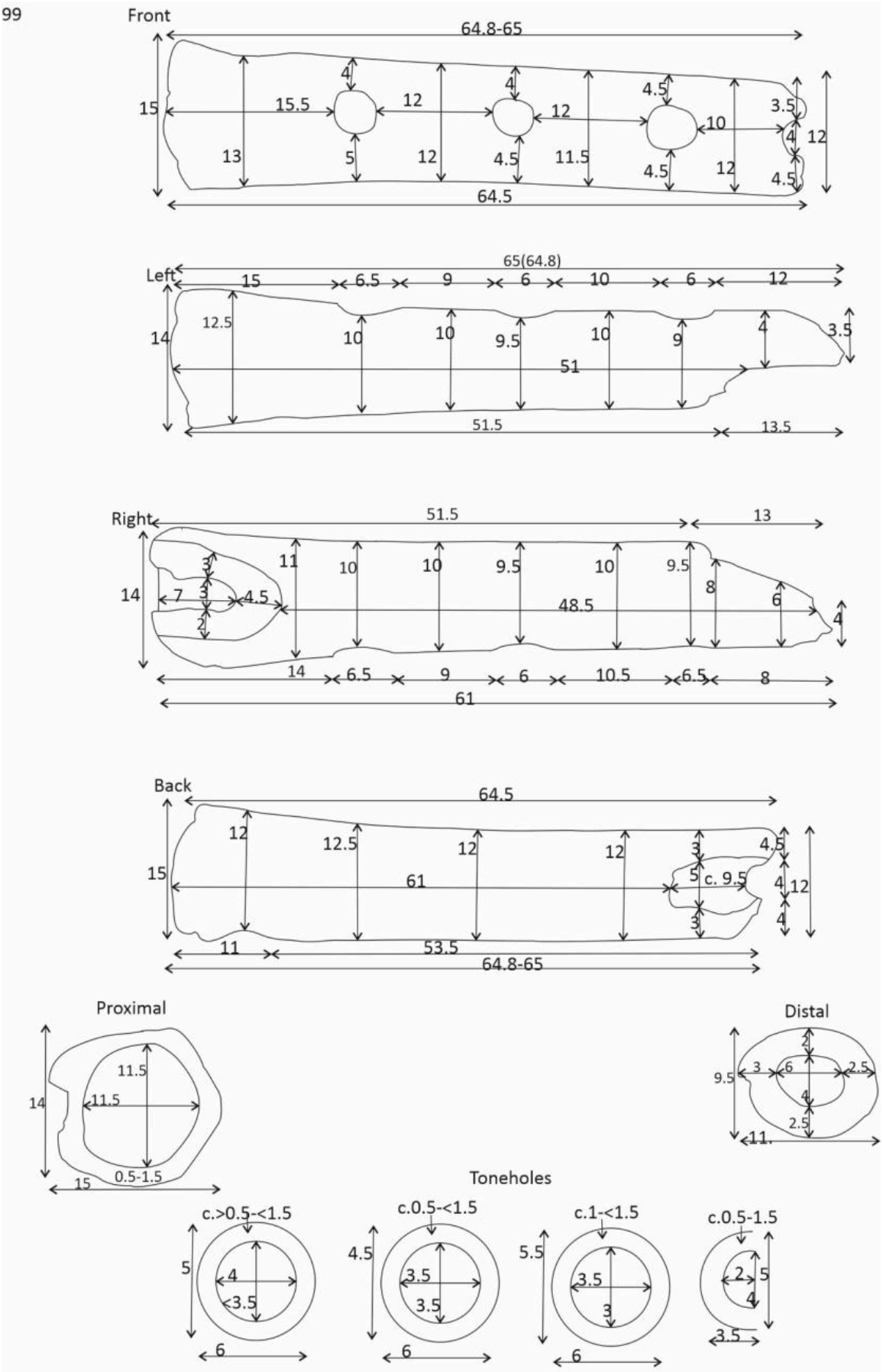

FIG 3. MEASUREMENTS (MM) OF THE BONE PIPE, INCLUDING FINGERHOLES, FOUND AT WICKEN BONHUNT (AD1000-1100). DRAWING BY LUCY-ANNE TAYLOR

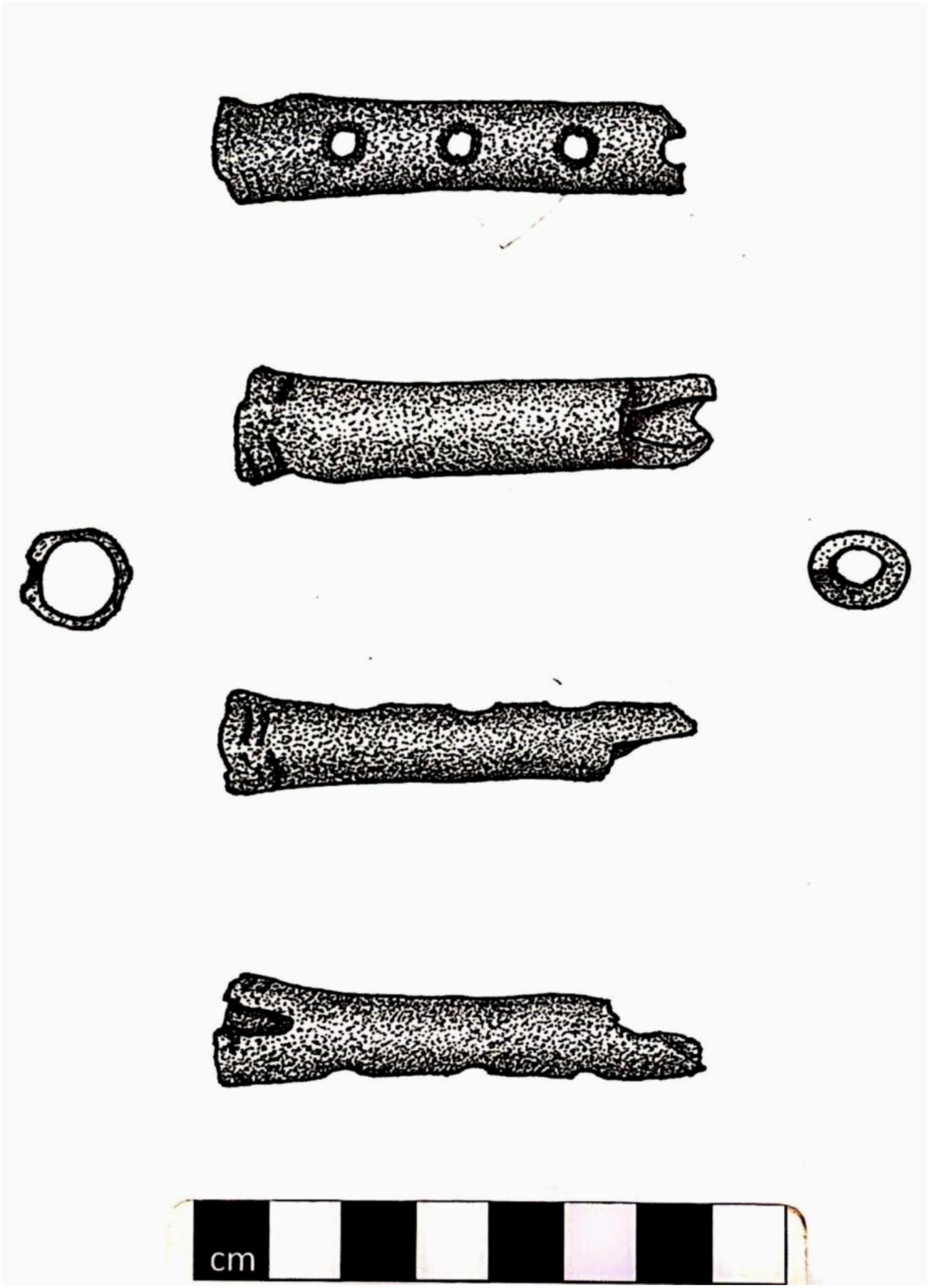

FIG 4. DRAWING OF THE BONE PIPE FOUND AT WICKEN BONHUNT, NORTH-WEST ESSEX (AD 1000-1100), SMALL FIND NUMBER 54. DRAWING BY LUCY-ANNE TAYLOR

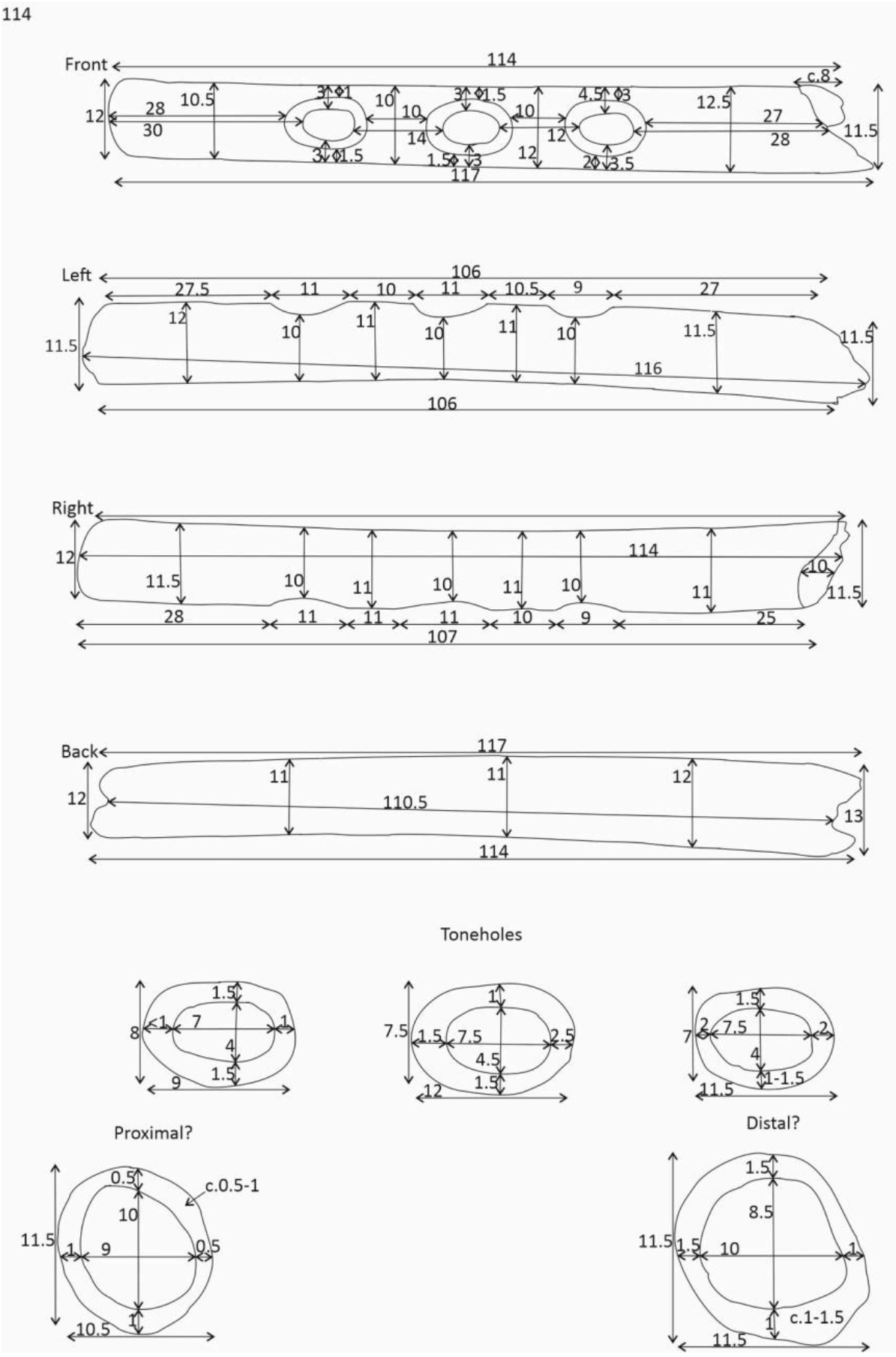

FIG 5. MEASUREMENTS (MM) OF THE BONE PIPE, INCLUDING FINGERHOLES, FOUND AT CLIFFORD STREET, YORK SMALL FINDS NUMBER C666. DRAWING BY LUCY-ANNE TAYLOR

FIG 6. DRAWING OF THE BONE PIPE FOUND AT CLIFFORD STREET, YORK (AD 975-1100), SMALL FIND NUMBER C666. DRAWING BY LUCY-ANNE TAYLOR

FIG 7A. SINGLE REED MADE FROM PHRAGMITES AUSTRALIS. MADE AND PHOTO BY LUCY-ANNE TAYLOR

FIG 7B. SINGLE REED MADE FROM PHRAGMITES AUSTRALIS. MADE AND PHOTO BY LUCY-ANNE TAYLOR

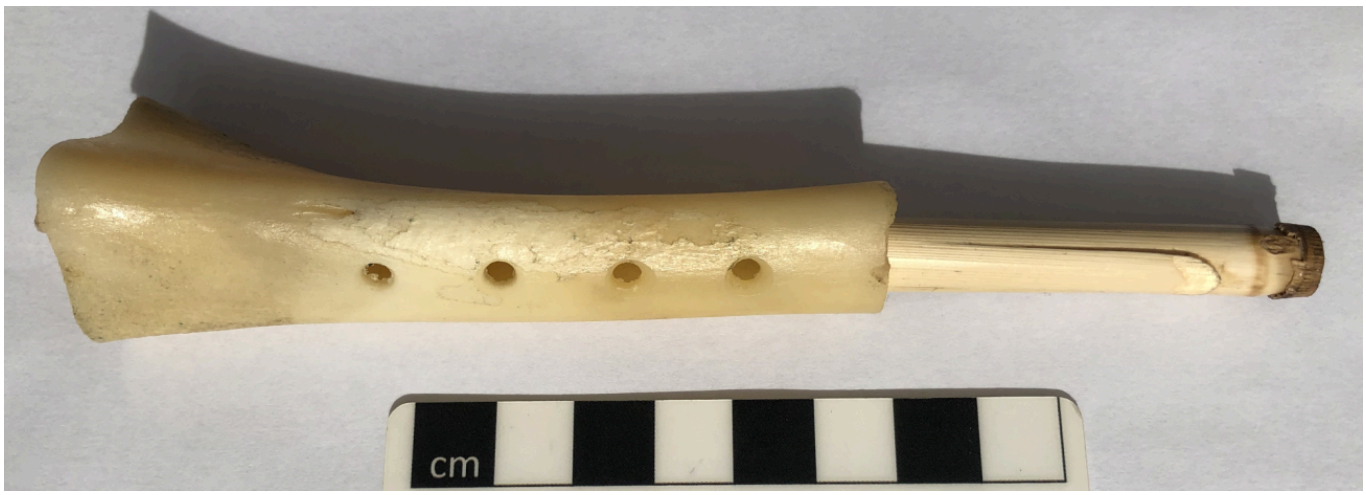

FIG 8A. THE BONE PIPE FOUND AT WICKEN BONHUNT (NORTH-WEST ESSEX) RE-CREATED AS A REED PIPE AND DUCT FLUTE. MADE AND PHOTO BY LUCY-ANNE TAYLOR

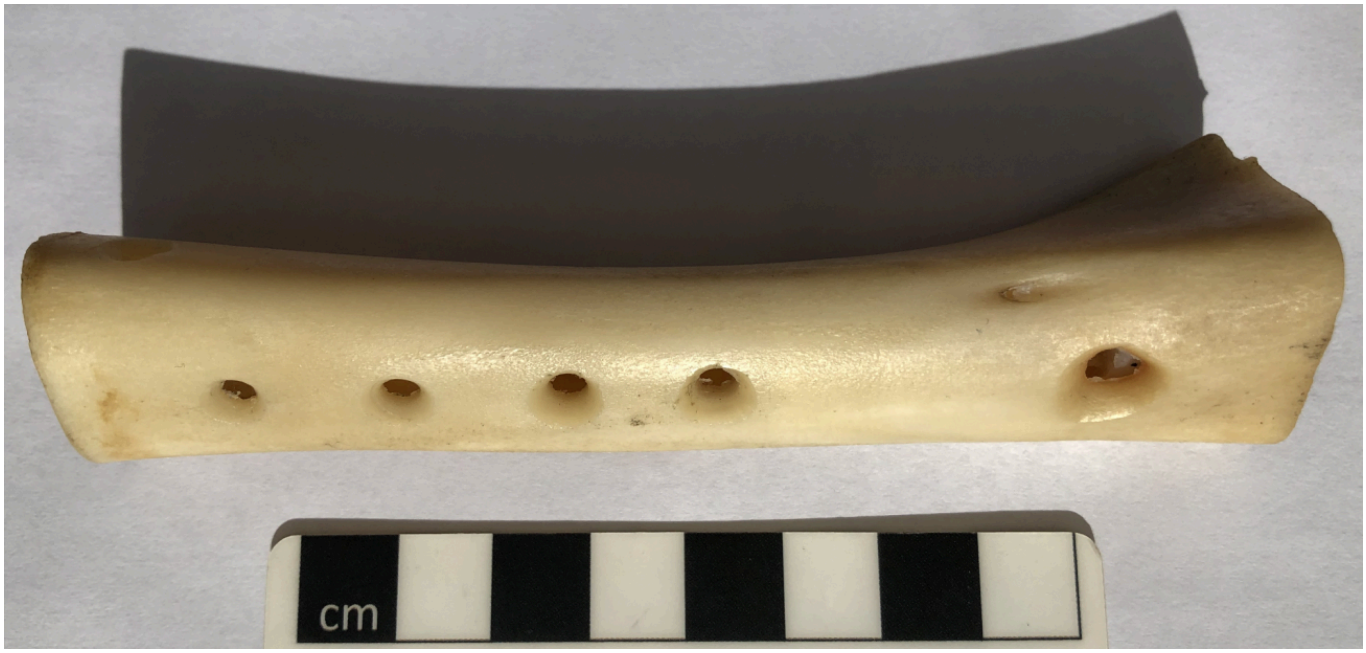

FIG 8B. THE BONE PIPE FOUND AT WICKEN BONHUNT (NORTH-WEST ESSEX) RE-CREATED AS A REED PIPE AND DUCT FLUTE. MADE AND PHOTO BY LUCY-ANNE TAYLOR

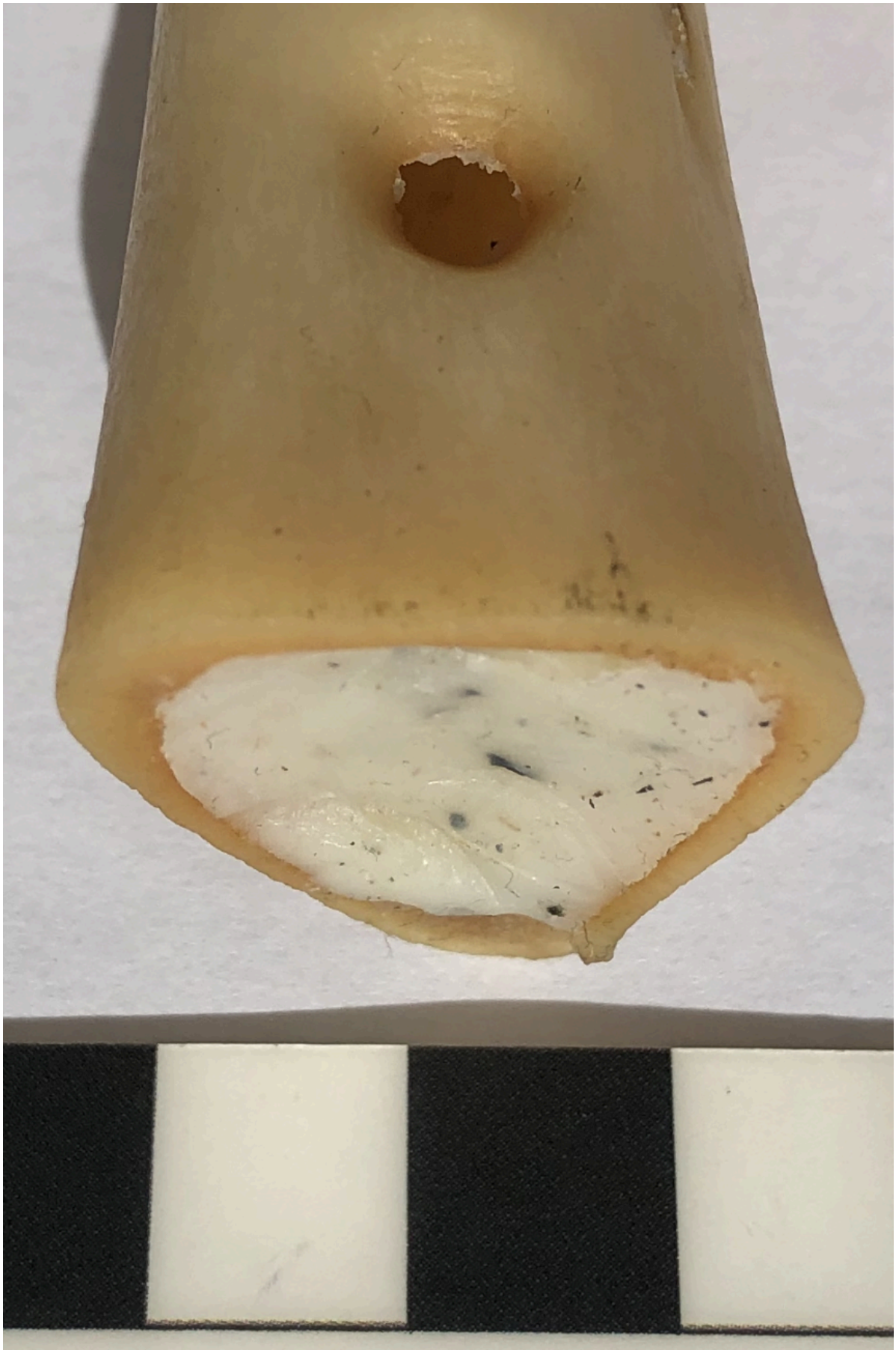

FIG 8C. THE BONE PIPE FOUND AT WICKEN BONHUNT (NORTH-WEST ESSEX) RE-CREATED AS A REED PIPE AND DUCT FLUTE. MADE AND PHOTO BY LUCY-ANNE TAYLOR

FIG 9A. BONE PIPE FROM CLIFFORD STREET, YORK RE-CREATED AS A REED PIPE AND DUCT FLUTE. MADE AND PHOTO BY LUCY-ANNE TAYLOR

FIG 9B. BONE PIPE FROM CLIFFORD STREET, YORK RE-CREATED AS A REED PIPE AND DUCT FLUTE. MADE AND PHOTO BY LUCY-ANNE TAYLOR

FIG 9C. BONE PIPE FROM CLIFFORD STREET, YORK RE-CREATED AS A REED PIPE AND DUCT FLUTE. MADE AND PHOTO BY LUCY-ANNE TAYLOR

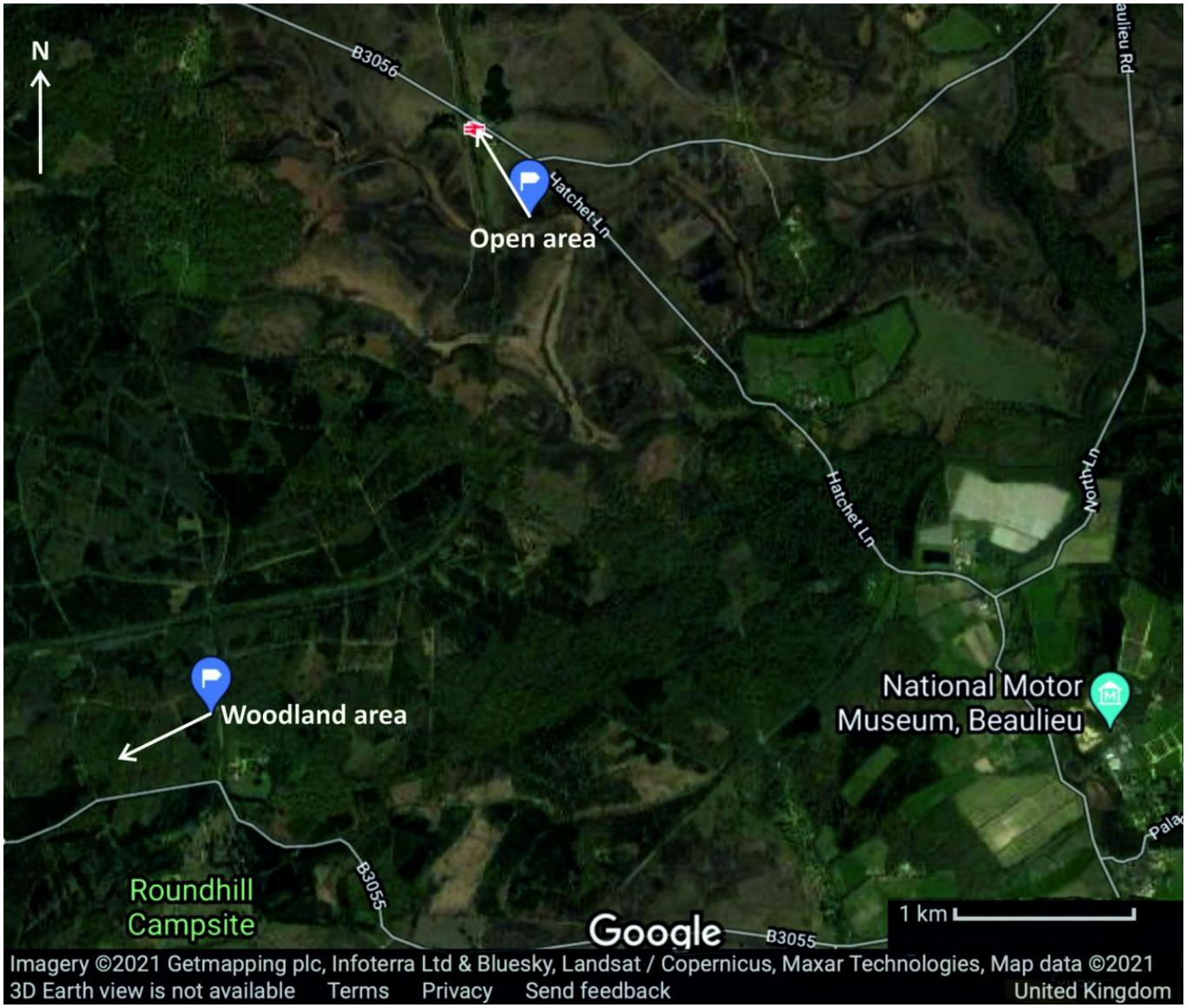

FIG 10. THE PLACES IN THE NEW FOREST WHERE THE INSTRUMENTS WERE MEASURED AND RECORDED. MAP DOWNLOADED FROM GOOGLE MAPS AND ANNOTATED BY THE AUTHOR.

FIG 12. RE-CREATED WICKEN BONHUNT BONE PIPE AS A DUCT FLUTE SHOWING THE ADDITIONAL HOLE ON THE SIDE USED TO HANG THE INSTRUMENT. MADE AND PHOTO BY LUCY-ANNE TAYLOR

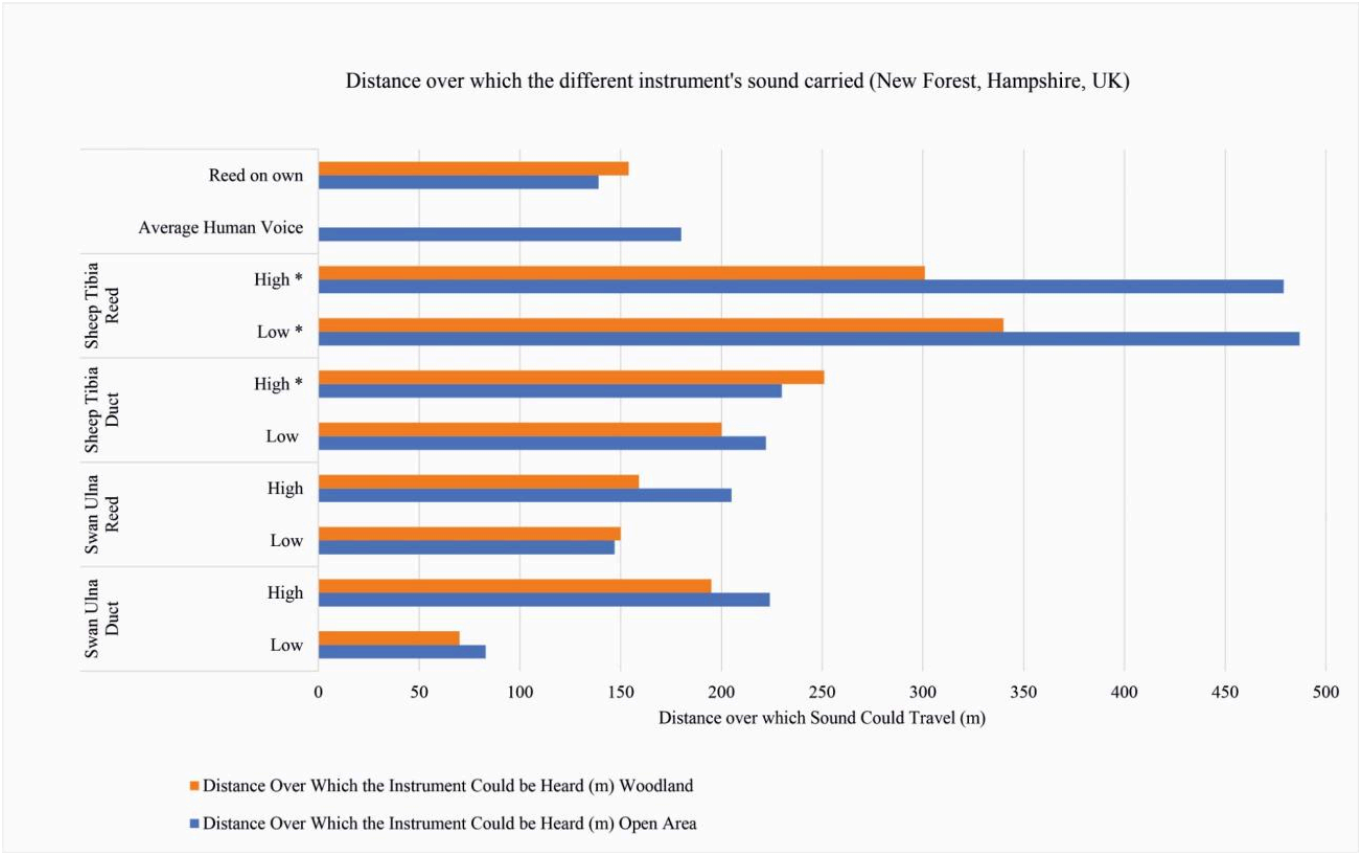

FIG 11. THE DISTANCES OVER WHICH THE INSTRUMENTS COULD BE HEARD IN BOTH OPEN AND WOODLAND AREA.