

Introduction

Musical and sound instruments were present throughout the society of early medieval England. Evidence for them survives in literary and iconographic sources, as well as in the archaeological record, the primary focus of this book. While those instruments that have survived are frequently poorly preserved, even in this poor state their stories can begin to be unravelled. This book will review the evidence for the wind instruments of early medieval England: their appearance, the skills and construction methods required to create them, their uses and social contexts, as well as briefly venturing into the soundscapes of the time.

A society is hard to fully comprehend without some idea of the sounds of the time. Instruments, particularly wind, were found in all sectors of early medieval English society. Musical instruments of early medieval England often show the apex of craft techniques (Leahy, 2003: 35) and enable new ideas about the people at the time including their capabilities and, to a certain extent, cultural priorities. Understanding of the music or sound and instruments will increase our understanding of early medieval England including their craftsmanship. The instruments were used in secular and religious contexts, for entertainment and practical purposes. Bone pipes have been used across many time periods around the world (Benito, 2018). They represent continuity and can be used to assess and compare many aspects of life in diverse cultural environments. The form may be different, but precursors to most, if not all, modern wind and brass instruments existed in early medieval England.

Some important aspects of the instruments and music have been omitted from this book. For example, the decoration on the instruments is only briefly discussed. Chordophones, membranophones and idiophones are not discussed in detail. Further information on chordophones can be found in Lawson (1980) and Page (1981). This book focuses on wind instruments, which are defined as any instrument (object) which produces sound through a vibrating column of air. Traditional wind instruments, such as those sounded in a flute style way and with reeds, and lip-vibrated sounding objects such as horns and trumpets are discussed. The organ is included because it produces sound through a vibrating column of air in each of the organ pipes. Producing sound in a common way means there are certain shared characteristics of the instruments described in this book. By creating sound through a vibrating column of air, the pitches wind instruments produce are affected by a phenomenon known today as end correction¹. Instruments such as buzz bones have

not been included as they produce sound when whirled through the air and not through a vibrating column of air.

The early medieval period in England extends from when the Roman administration collapsed in the early fifth century to the Norman Conquest of AD 1066. The historical time periods do not entirely align with cultural changes, and musical instruments from earlier times continued being played beyond the Norman Conquest. Consequently, a time frame of evidence from about AD 450 to 1200 will be used in this book. The majority of sources for early medieval wind instruments in England date from the ninth to 10th centuries, placing them unequivocally within the early medieval period. During this time, Christianity spread across England and possible ecclesiastical use of the instruments is important to consider. Early medieval wind instruments in England have been found in diverse contexts including religious, secular, urban and rural.

The focus of this book is on England. While there will be occasional reference to instruments from the rest of Britain and Ireland, a more complete comparison will be left for future work.

Historical publications on early medieval wind instruments

In 1837 Francis Diederich Wackerbarth published one of the first studies of early medieval musical instruments in England, entitled *Music and the Anglo-Saxons: Being Some Account of the Anglo-Saxon Orchestra. With Remarks on the Church Music of the Nineteenth Century*. Wackerbarth wrote on a number of different topics, many of which were of a religious or political nature, and often contrasted past- and present-day, which his work on 'Anglo-Saxon' music does (Royal Astronomical Society, 1885: 200-203). In his book, Wackerbarth discusses the idea of an 'Anglo-Saxon' orchestra, comparing it to his contemporary day (Wackerbarth, 1837). There was no concept of an orchestra in early medieval times and some of the instruments Wackerbarth described did not exist. Wackerbarth (1837: 6) himself stated that 'due to his confinement and present situation [his research] into instruments [was] sadly limited and defective'. Despite these limitations, Wackerbarth's book was a significant first step in the study of early medieval wind instruments in England.

One hundred and thirty five years later, in 1972, Frederick Crane wrote *Extant Medieval Musical Instruments* which lists instruments according to categories. The book is useful for studying the instruments that were known when the book was written, although later some of the

¹ An acoustical phenomenon where the length of a pipe to achieve a specific pitch is not the exact length that calculations indicate it should be.

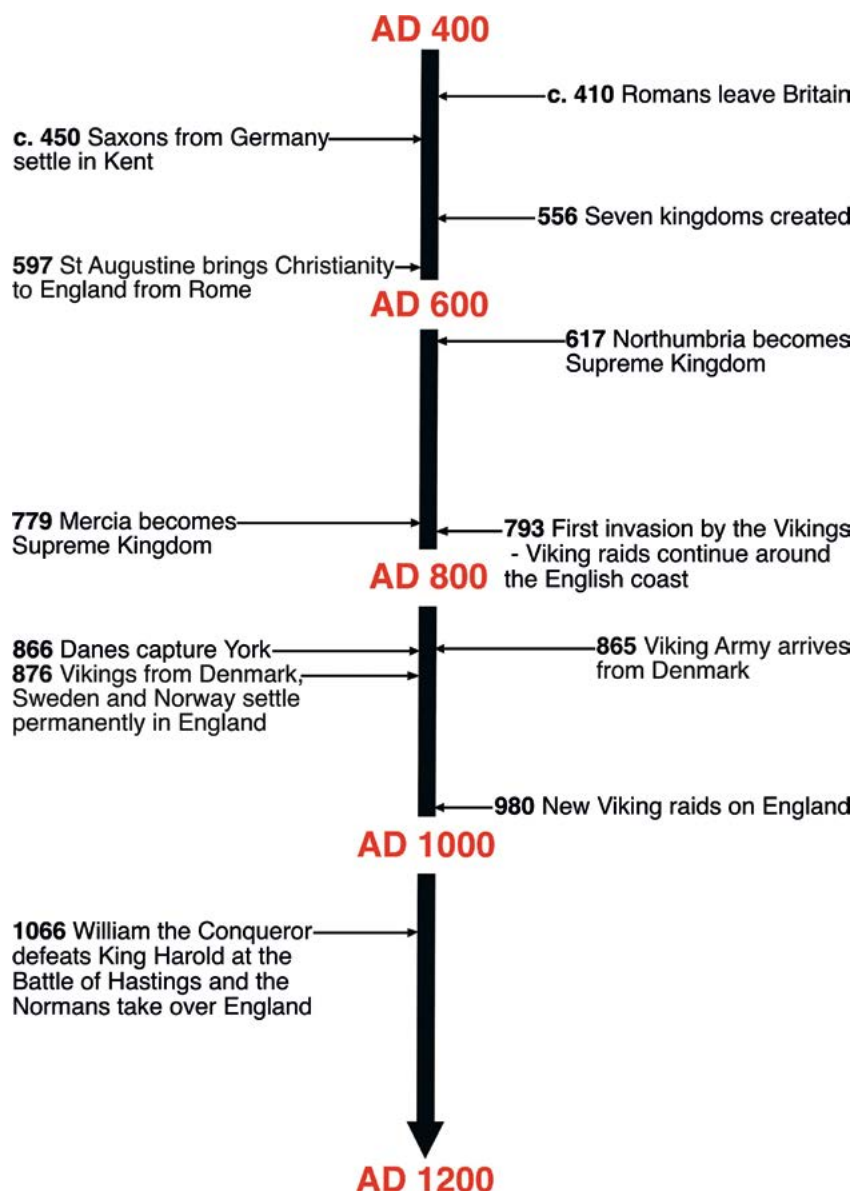


Figure 1.1: Timeline of relevant early medieval dates in England.

instruments were found to be wrongly classified or have been discovered, or rediscovered, more recently. Aside from mentions of early medieval English wind instruments in works by researchers such as Francis Galpin (1910) and Vincent Megaw (1961), or in catalogues, no further in-depth works on the topic were written until Ernst Benko’s 1983 PhD thesis, *Anglo-Saxon Musical Instruments*. Writing his thesis at State University, New York, Benko collated all the references (literary, iconographic and archaeological) that he thought existed for the instruments from early medieval England. Benko’s (1983) list of sources can be useful, but he does not write any conclusive analysis about the instruments. More recent research has shown a number of his sources were inaccurate or re-dated to a different time period, and the range of instruments he suggests were present in early medieval England may not be correct. For example, Benko (1983: 180-182) has a section on the Jew’s harp, but the finds he mentions are not corroborated and the dates, according to Kolltveit (2006: 113), are hard to substantiate. Despite this, the existence

of the Jew’s harp in Europe in the early Middle Ages cannot be excluded, and archaeological finds indicate that it was a common instrument in Europe by the 13th century (Kolltveit, 2006: 113). The other major work on some of the wind instruments in early medieval England is Helen Leaf’s 2008 PhD thesis, entitled *English Medieval Bone Flutes, c.450-1550 AD* (discussed in more detail in Chapter 4).

Methods, sources and theory

Instruments, particularly those voiced by a vibrating column of air in a semi-enclosed windway, have been found throughout the world since the Palaeolithic period. A bone pipe found at Hohle Fels, Germany, along with two ivory instruments, dated to over 35,000 years ago, is believed to be the oldest intentionally crafted sound tool discovered (D’Sousa and Cunha, 2012: 307; Morley, 2013: 47). An interest in past music from an archaeological or antiquarian perspective goes back several hundred years;

with antiquarians such as Samuel Pegge (1775), Daines Barrington (1775) and Charles Edmond de Coussemaker (1846) who ‘thought of music as lying comfortably in their domain’ (Lawson, 2010a: 110-111). These early writings are important in understanding the development of the discipline, and future research builds on such works. Losses of evidence and objects since excavation mean that these early publications sometimes represent the only information about certain artefacts and sources (Lawson, 2010a: 108). Even in the classical world, there was an awareness of past ‘musical cultures’ and ‘instruments’.

In the early 1980s, the music archaeology section of the ICTMD (International Council for Traditional Music and Dance) was formed by Ellen Hickmann, Peter Holmes, Graeme Lawson and Cajsa Lund, among others. The group allows people studying past music and sound-producing devices from different time periods worldwide to come together and discuss ideas. Publications from the ICTM (such as Kolltveit and Rainio 2020; Both, Hughes and Stöckli 2020; Jiménez, Till and Howell, 2013; ICTM 2015 a and b) give a wider understanding of the topic and methodologies than is outlined here. The group continues to meet. Later, partly due to interest in the topic from outside of Europe, especially in China, ISGMA (the International Study Group on Music Archaeology) was formed as a worldwide group with biannual conferences. These conferences and meetings are often the venues to discuss new ideas in the field (Kolltveit, 2010: 76). A list of publications from these conferences can be found on the ISGMA website. Publications from these conferences, and music archaeologists around the world, after 2021 can be found in the *Journal of Music Archaeology*.

The considerable time periods, geographical areas and different societies to which music archaeology is relevant have resulted in many different methodologies and approaches, details of which can be found in publications such as Both (2009) and the ICTM and ISGMA publications. The methodologies required for the research depend on the project, and the sources available. The primary focus of this book is the archaeological sources. Iconographic and literary sources are used when they inform our understanding of the archaeological evidence. Before assessing relevant methods and approaches, an understanding of classification is necessary.

In 1914, Erich Hornbostel and Curt Sachs published their classification system. While there have been updates since, for example in line with the MIMO (Musical Instruments Museums Online) project in 2011, the system is still used today. Sachs and Hornbostel’s is the only classification system for instruments that is not specific to one culture or language due to its use of numbers rather than words (Montagu, 2017: 1). This method categorises instruments based on their characteristics, defining over 300 sub-categories. The system divides instruments into idiophones, membranophones, chordophones, aerophones and electrophones, with many sub-categories within these. There are problems with such a classification, including

difficulties in defining an instrument to specific sub-categories (Montagu, 2017: 2). For example, an instrument could be an aerophone, but the exact member of the family may be less clear. Megaw (1968b: 341-342) suggested that some bone pipes with no apparent voicing lip may represent the surviving part where a straw or beating reed could originally have been added. The Hornbostel-Sachs system may not be comprehensive and its categories may be too narrow for some sound-producing devices, but it is still relevant.

Sachs and Hornbostel’s system is only appropriate when an object’s use as a sounding instrument is confirmed: it does not allow for sound-producing objects which are not ‘instruments’ as categorised in Sachs and Hornbostel’s system. Consequently, another system is required to establish if an object was indeed used for sounding. The other system, suggested by Lund (1981a: 247), is ‘probability grouping’. This classification system has five categories: 1) definite sound-producing devices such as lurs and bells; 2) objects with strong potential to be sound-producing devices (for example, certain pierced pig bones); 3) probable sound-producing artefacts from ethnographic sources (for example, shell necklaces or metal objects); 4) artefacts which were probably not used primarily for sound production but, due to their design, generate sound as a secondary function when used, such as silver bracelets; 5) artefacts of unknown use, but have a design that means they generate sound as one function, such as bone objects with carved-out notches (Lund, 1981a: 247). This is a good system to use when an object’s purpose as a sound device is questioned. Experiments can be carried out on instruments to investigate their sound-producing properties but there will be uncertainty about how the experimental conditions compare with those of the time from which the object came (Safa; et al., 2016: 11).

For some periods the use of objects as instruments is clearer than for others and consequently the requirement for both systems is dependent on what is being studied and should be assessed by the individual researcher. For example, generally, the wind instruments of early medieval England can fairly certainly be ascribed as sound producing devices and consequently only the Sachs and Hornbostel classification system need be used, although for a few objects the use is still unclear and therefore Lund’s system is important to consult.

Methodological approaches used in this book

Archaeological remains are unique in that they constitute actual material survival whereas iconographic and literary sources have been committed to an artificial medium by human agency (Lawson, 1981: 5, 2). An investigation using only archaeological material has pitfalls. The loss from the archaeological record, whether through decay, overlooked upon excavation or not having been excavated, means what we have may only be a fraction of the instruments and music which was around for a given time period.

Lack of evidence in the archaeological record can mean the object never existed or that it has since degraded, was re-purposed prior to deposition or has not yet been found (Morley, 2013: 129). It is important to constantly consider the fragility of archaeological evidence and how we may not be dealing with the full picture however much evidence we think we have. In addition, some sound or music artefacts are currently lying unidentified or misidentified in museum collections and the researcher has now to go through collections to identify such objects. Texts and images can enable instruments from the archaeological record to be identified, including when they have been mis-categorised. Such sources of evidence also give indications of uses and construction methods, not always discernible through the archaeological specimens alone. For these reasons, while the focus of this book is on the archaeological evidence, iconographic and literary sources will be consulted when required to assess the instruments.

When correctly dated, archaeological finds provide clear evidence for existence and craftsmanship and show aspects not identifiable from depictions or descriptions. However, the scarcity of such finds and their frequently disputed or misunderstood nature, means literary and pictorial sources need to be used in conjunction to understand the wind instruments. Texts and images can enable instruments from the archaeological record to be identified, including recognising previously mis-categorised objects and provide evidence for aspects such as use and methods of playing, not always discernible from studying the archaeological specimens alone. Evidence from England has been used to assess the early medieval English wind instruments, but that from other contemporary cultures throughout Europe has also been considered where appropriate.

While iconographic, and literary, sources can be extremely useful, they can be misleading, as they might have been copied, imagined or idealised (Lawson, 1981: 2-5). Their date is often ambiguous, and some which provide evidence for the instruments fall just after the early medieval period but are close enough to represent similar instruments, something which is also true of the archaeological evidence. More iconographic and literary sources existed but have been lost due to events such as the Cotton Fire² and destruction during the Commonwealth period under Oliver Cromwell. Sources from the continent have also been used as they sometimes offer insight which has not survived (or not yet been found) in Britain and Ireland. The instruments did not change overnight, making the use of some slightly later sources, especially when supported by earlier evidence, appropriate.

The types of evidence for different instruments vary. Bone pipes, for example, exist archaeologically, but rarely, if ever, appear in the contemporary written and pictorial record, while the horn, trumpet and organ are referenced in images

and texts, but have rarely been identified archaeologically. Therefore, the different types of sources need to be used in conjunction with each other to gain a fuller understanding of early medieval English wind instruments, and to assess the reliability of the sources themselves. A brief overview of the types of evidence, how they are assessed and what exists follows.

Archaeological sources

Figure 1.2 shows the places in England known to have been associated with early medieval instruments. The majority of these are finds' spots of instruments excavated archaeologically. However, the organs on the map are those which are referenced in literary sources at specific locations. The horns have not been included on the map as the finds may represent drinking or sound-tool horns (discussed in Chapter 2). The lyres are included for interest. Where the archaeological finds existed, they were located through museum collections or archaeological artefact assemblage publications and catalogues of instruments.

Once the primary evidence had been assessed re-creations allow for further understanding of how they were sounded and the amount of air pressure required to play instruments such as the organ. The making of and experimentation with the re-creations is mentioned in Chapters 2 to 6, and focused on in Chapter 7, where the re-creations are used to undertake original experiments in how far away the instruments could be heard. Videos were created to show how the re-creations sounded.

Making re-creations and experimentation, seen as an important research technique in music archaeology (Both, 2009: 7-9), allow aspects to be assessed which may have been missed and allow a more tactile aspect of music archaeology to be investigated, which may engage people beyond the usual scholars. Megaw (1968b: 337) and other scholars have given examples including assessments of tuning frameworks possible through experimentation with re-creations. However, caution is required when working with re-creations, as highlighted by scholars such as Gill (2012: 5), Both (2009: 1-11), Reiners (1997: 31), Leech-Wilkinson (2002: 87) and Junej and Turk (2001: 261).

Iconographic sources

Illustrations can offer unique insight into the instruments, including how contemporary people understood them, and playing techniques, greatly assisting organological research (Buckley, 1998b: 6). They may provide new insights, increasing our knowledge and understanding of the topic (Baldassarre, 2000: 38). However, illustrations may have been copied from earlier depictions or include elements of imagination and may not accurately represent the intended object (Dodwell, 1982: 171). Some of the objects depicted in manuscripts are not exactly those which were around in early medieval England (Carver, 1986). Images which accompany texts from an earlier period, such as the Bible, may be depicting instruments

² In 1731 a fire at Ashburnham House, London, destroyed and damaged nearly a quarter of the manuscripts of the Cotton Library which was housed there through both fire and water damage.

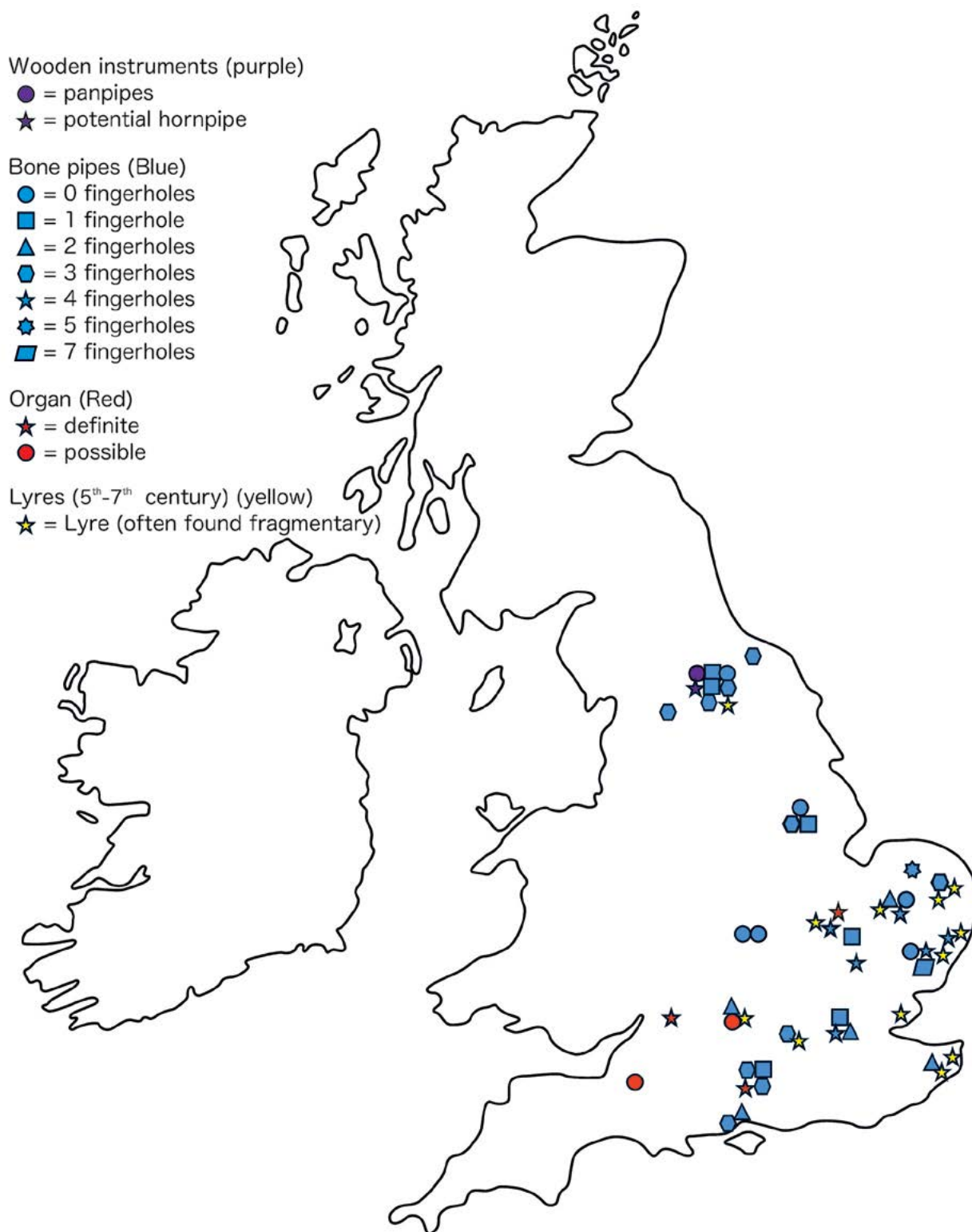


Figure 1.2: Map showing the geographical distribution of instruments from early medieval England that have either been found archaeologically or, in the case of the organs, are evidenced in written sources. Created by the author using map outline by kind permission of Cosmographics Ltd.

described which were only known about from texts rather than those physically present. If other sources corroborate the instruments, the accuracy is more secure. The images are sometimes crude or feint and difficult to establish exactly what was depicted.

Despite these limitations manuscripts are one of the richest iconographic sources. The texts and material evidence from the time may corroborate the contemporary images, which include instruments such as, horns, the organ and lyres, and if they support each other the description or depiction is more likely to be accurate. Instruments

may have been lost due to decay or reuse of parts, but if archaeological specimens exist in other geographical places, the use of images featuring those instruments can help to reveal what instruments were around at the time and how they looked, such as with the material find of the River Erne horn or trumpet and depiction of King David and his musicians (Chapter 2). This demonstrates the importance of assessing manuscript images even though the focus is on the material evidence. Carvings are also a useful form of evidence, but their accuracy should be considered.

Instruments are featured in the Bayeux Tapestry. The depictions in the Bayeux Tapestry relate closely to events of the early medieval period. Despite dating to just after that period and from the continent, the Bayeux Tapestry gives a fairly accurate account of early medieval England (Brooks and Walker, 1997; Berlin, 2003), although it should still be treated with caution and assessed in combination with the other sources. The main scene illustrates the battle and royalty, but the borders depict everyday activities, offering insight into how the people lived. The depictions of instruments within the Bayeux Tapestry are limited. Only bells, at Edward the Confessor's funeral, and horns are shown.

Literary sources

The literary evidence for early medieval instruments in England is varied and non-existent for some instruments, but references to others can be found in various mediums, including riddles, epic poems, law codes, religious texts, and technical treatises. Multiple translations of each text, generally written in Latin or Old English, were compared to remove inaccuracies and ensure appropriate interpretation. In both Old English and Latin, multiple words for each instrument often existed and at times the words had diverse meanings. Frederick Padelford's 1899 *Old English Musical Terms* contains an useful glossary. On occasions one instrument is known by different words in the original language, or one word means multiple different instruments which were perhaps not distinguished between and to distinguish between them now may impinge our ability to see the differences and potential significance of such instruments. To ensure accuracy and avoid bias the origins of the literary sources had to be established. As with images, the accuracy of texts can be clarified through looking at other texts, images and archaeological specimens. If they support each other, they are more likely to be accurate.

Riddles in both art and textual form were common in early medieval England (Leigh, 1984: 35-36). Riddles, such as those in the Exeter Book, describe objects known to the creator in such a way that people could have guessed, or at least attempted to guess, and describe or depict objects which were in common usage, offering a snapshot into early medieval English everyday life and perception of objects (Crossley-Holland, 2015). Due to the nature of a riddle, these texts can give more accurate descriptions of

what the objects were like and how they were perceived than other descriptions from the time, making the riddles invaluable resources for the objects described.

Epic poems, such as *Beowulf* mention instruments. Lip-vibrated instruments, generally translated as horns or trumpets and appearing in battle scenes, and lyres, generally for entertainment, are the most commonly described instruments in the epics. These texts, notably *Elene* and *Beowulf*, give an idea about the situations in which the instruments were used.

Surviving law codes from the period give insight into how some of the instruments were used within society. The Laws of King Wihtred of Kent, dating from AD 695, and Welsh Laws of Hywel Dda (AD 949-950), preserved in the *Black Book of Chirk* and *Book of Colan*, mention sounding instruments. There is some debate as to which instrument they refer, due to disagreements amongst scholars of the exact meanings of the original words. Consequently, translations of them shall be treated with caution. It is unclear how widespread these laws were and at what point they came into being.

When instruments are mentioned in religious texts, such as the Bible, it is uncertain if they were present in early medieval England, as these texts were often copied and translated from earlier examples. Unless other evidence is found to corroborate the presence of the instruments mentioned in such texts, they will only be used where appropriate to suggest potential knowledge of the instruments, and not to indicate the actual presence of the instruments. Other religious texts, such as Bede's Ecclesiastical History may record more accurately what was around, but, should still be treated critically. There are also some texts, particularly for the organ, which describe at least the location, if not the appearance of such instruments. These are often as parts of larger descriptions about a specific place such as an Abbey or a person's life such as St Swithun.

The fullest account for the construction of the organ pre-15th century is Theophilus' treatise, *De Diversis Artibus* (Williams 1993: 253; Hopkins, 1870: 32). The treatise covers how many different objects were constructed including the craft and art techniques. Theophilus' work is widely agreed to be a source of great importance on many forms of early medieval arts and crafts in England, despite its probable 12th-century date and continental origins from around Germany (Leahy, 2003: 12). Peter Williams (1993: 272) suggests that the writing on the organ may be in keeping with organs used around AD 1060-1090. Additionally, there is a body of work on measuring organ pipes. These excerpts, generally written in Latin, are mainly in music theory treatises and comprise some of the best sources for music theory of the time. While these treatises need to be treated with caution, they offer a unique understanding of pipe dimensions. A brief overview of music theory relevant to understanding aspects of this book is outlined at the end of this chapter.

Chapter outline

The main categories of wind instruments are: horns and trumpets, hornpipes and bagpipes, bone pipes, panpipes and the organ. They are separated into these groups based on the way the sound is produced. Horns and trumpets use the vibrating of the lips to create sound. Pipes use a sounding mouth part, such as air rushing over an opening or a reed vibrating; hornpipes and bagpipes have additional parts, often acting as air reservoirs, bells or reed caps. The organ is a more complex instrument of multiple parts. Chapters 2 to 6 each take one of these sub-categories of the instruments and establish the nature of the available evidence, providing an assessment of the instruments' presence in early medieval England, when they may have been used, as well as their construction and workings. Each of these chapters will consist of the following:

- An overview of the current state of knowledge and a brief history of the instrument, including whether the instrument is known to have existed before the early medieval period
- A consideration of problems relating to the terminology connected with each instrument
- A critical analysis of the evidence for the instrument (archaeological, literary and iconographical), including problems of being wrongly catalogued
- Re-creations of the instruments, which sometimes allowed for further experimentation
- Discussion and conclusions regarding what has been established about each instrument in line with the research aims

The evidence for each type of instrument differs and dictates how it should be assessed. The following paragraphs outline the approach for each category.

Horns and trumpets

The sources for horns and trumpets are limited although more numerous than for some other wind instruments. No archaeological specimens dating from early medieval England are universally agreed to be sound-tool horns, with the majority of findings of metal fittings for horns categorised as drinking vessels. To establish whether horns were used for sound production as well as drinking, texts, such as epic poems, riddles and law codes, and images, including manuscripts, carvings and the Bayeux Tapestry, from the time which featured horns and trumpets were assessed. The potential archaeological evidence could then be analysed.

Bagpipes and hornpipes

The evidence for bagpipes and hornpipes is limited. The only possible written evidence for the bagpipe is a riddle. To establish the true meaning of the riddle the author drew what was described. There are a few depictions of hornpipes and bagpipes, but these date to after the early medieval period, which was considered when looking at what they depict and their contexts.

The limited evidence in England for hornpipes and bagpipes during the early medieval period meant evidence from contemporary societies who were known to have had links to England was assessed. There are early medieval northern European archaeological finds of hornpipes. A careful assessment of what the components of hornpipes and bagpipes may have looked like and whether their parts could have been made at the time along with the finds from other contemporary places meant any potential archaeological finds from early medieval England could be identified. This, along with a re-creation, helped understand the type of instrument represented by a find from Hungate, York.

Bone pipes and panpipes

Archaeological finds constitute the majority of evidence for bone pipes, and there is more of this type of evidence than for any of the other wind instruments. The assessment of bone pipes is made largely from the archaeological record. Each bone pipe, once located, was visited and carefully assessed. The archaeological evidence existing in England for the time period, meant that although the instruments and bone pipes of other countries were taken into account they were not assessed in the same way as for the other instruments.

To discover the archaeological specimens, various sources were consulted, including artefact assemblage publications and works on bone pipes, particularly Helen Leaf's 2008 PhD thesis. She collated all the bone 'flutes' known for the period at the time of writing her thesis. Other examples have since been found. Through a thorough study of the museum collection catalogues and archaeological finds reports and being contacted when new finds were discovered, the location of the majority of the bone pipes was found. In addition, involvement in excavations at sites from the period, such as Cookham Abbey being undertaken by the University of Reading, ensured that when an example was found there the author was immediately contacted. However, some specimens, where the collections were closed to all researchers, or the instrument's current whereabouts unknown, could not be visited. All the information gained from other sources such as site reports and Leaf's catalogue, was collated, including taking measurements so that the instruments could be assessed as fully as possible.

Problems of dating the bone pipes meant the results could not be broken down into early and late early medieval period instruments. This did not appear to skew the results and the technology and making of instruments would not have changed overnight. Some of the bone pipes are not securely dated and these are highlighted.

Organs

The complexity of the organ and the nature of the sources, requires the most diverse and wide-ranging methodology. The first step was identifying the sources and assimilating them in such a way that analysis and comparison could take place. The three types of sources (archaeological,

iconographic and literary) all show a unique perspective and together can help form a full picture. Despite no currently identified archaeological evidence, some objects which represented organ parts may exist but have been previously misidentified. In order to identify these parts, literary and iconographic sources were consulted to establish the construction and appearance of the organ. Once the components of the organ were established, archaeological site reports and collections were examined to identify any objects resembling those parts, or, at the very least objects which demonstrated the craft techniques and abilities required for each section. Given the focus on the material data and construction, unless the literary and iconographic sources related to this, they were not analysed in further detail. A variety of approaches were used to find the iconographic and literary sources.

The majority of images depicting organs from the time are mentioned in Galpin (1910), Benko (1983) Fenlon (1982) and Williams (1993) and therefore these were the starting points from which the originals were found. Having discovered the originals, the manuscript images could be compared and analysed. Some of these images originated outside England but were nonetheless considered since organ construction was probably the same across northern Europe. However, the depictions could have been copied or contrived, and therefore to fully assess the accuracy of the images, other sources had to be assessed. There are some examples where manuscripts are known to have been copied, such as the Utrecht Psalter. Therefore, apart from using the Harley Psalter (which was copied from the Utrecht Psalter) as an example, other references known to have been copied are not included as they do not offer additional useful evidence in relation to the aims of this book.

While there are some previous collations of written sources relating to the organ of the time, in works such as Williams (1993), a careful assessment of material from early medieval England was undertaken to discover the primary sources, written in Latin or Old English. To undertake such a study, the possible words for organ in those languages had to be established. Having found the texts, translations were sourced. When a source offered little information beyond the presence of an organ existing translations were used. However, for sources which were more descriptive of the early medieval organ, notably Wulfstan's (c.AD 960-1023) description of the Winchester instrument (AD 996), further translations had to be sought from specialists in classics who had no vested interests in the outcome of the text, such as Professor Stephen Oakley and Kate Conway MA.

Theophilus' (1070-1127) *De Diversis Artibus* (1100-1120) on organ building offers one of the few descriptions of how an organ was built and worked. The treatise has been translated by scholars and the English version is offered next to the original Latin allowing for it to be used by the author without further translations. The best way to understand the mechanism described, given the complexity of the written source, was through drawing.

A further set of written sources for the organ are the treatises on pipe dimensions. A comprehensive list of these are given by Sachs (1970). These treatises date from the early to later medieval period and are from across northern Europe. Organ building did not change overnight; the instrument was broadly similar in form across northern Europe, and many of the treatises were probably available in England. Therefore, all the treatises were used for the present study, especially given they support each other with no suggestion of any particular or localised change. Once translated, the information in the texts was extracted and put into Excel spreadsheets. Acoustical testing was used to help understand the organ pipes and organ pipe treatises, notably utilising the computer program Physics COMSOL Multiphysics, with help from acoustical engineers (Dr Matthew Wright, Dr Tony Hart, Dr Neil Ferguson, Phil Oxborrow and Roy Haworth) and mathematicians (Andrew Lambourne and Dr Naomi Andrew).

Instrument range and audibility

Re-creations were made of some of the instruments. The re-creations were used for experiments and to test ideas in the individual instrument chapters and Chapter 7. The re-creations were made differently for the various instruments. Generally, the original craft techniques were used, to demonstrate how they were probably made in the early medieval period. An understanding of the relevant tools and craft techniques was gained through studying existing scholarship, such as Kevin Leahy's *Anglo-Saxon Crafts* (2003), and archaeological evidence for tools. The author attended two instrument-making courses, one involving wood (making a cornett) and the other involving metal (making a Baroque trumpet), run by Cambridge Woodwind Makers, using traditional craft techniques and tools available in early medieval England, such as wood-chiselling and hard and soft soldering, to ensure understanding of appropriate techniques. A woodworker, Jim Oliver, was also enlisted, and worked closely with the author to assist with making some of the re-creations. Detailed information of how the re-creations were made can be found in the individual chapters. Chapter 7 uses these re-creations in an experiment designed to assess the distances over which the instruments could be heard.

Conclusion

Based on the research described in this book a comparison and overall synthesis of the wind instruments is given, including the contexts in which the instruments were used and how they worked. The chapter concludes with an agenda for future research.

A brief overview of music theory

All music is comprised of distances between the pitches of individual notes. These distances have changed over time and vary in different places today, such as between traditional Chinese and modern European music. Today most western music is based on patterns of distances

described as tones and semitones. A tone is composed of two semitones. There is an identical distance (in terms of pitch) between the semitones, due to equal temperament, a tuning system that has been widely adopted today. Equal temperament, used since the late 17th century, but with a much longer history (Barbour, 1951: 45-87; Halewood, 2015), is the division of an octave into 12 equally spaced pitches, all a semitone apart. An octave being the description of the distance between two notes of the same pitch name. Before the standardisation brought about by equal temperament, the two semitones that comprised a tone could differ with one being larger and the other smaller. The majority of these intervals were based on Pythagorean ratios. Several books were available in early medieval England on music theory, including *Fundamentals of Music* by Boethius (c.AD 477-524) and *Musica Enchiriadis* by an unknown author (ninth century). More detailed discussion of these concepts can be found in *The Cambridge History of Western Music Theory* (Christensen, 2002) and *Equal Temperament and Pythagorean Tuning: A Geometrical Interpretation in the Plane* (Haluska, 2000). The other intervals, including those used in early medieval England such as fourths and fifths, are all comprised of tones and semitones (Table 1.1).

Table 1.1 gives an example of intervals including the number of semitones that comprise each interval. The intervals have been named in relation to modern western music theory, but during the early medieval period, they were probably referred to as third, fourth, fifth and so on. Therefore, in many cases intervals will be referred to in this manner. From the music theory treatises, which are largely based on Pythagorean ratios, the early medieval intervals relate roughly to the major second, major third and so on of modern western music theory, given in the table. Accidentals were introduced later as more modern tonality concepts emerged, so, for most cases, the accidentals will not be used. Given this, the example letter names given start from C, being the most common tonal centre to which the intervals can be related. Some of the instruments found from this time used different intervals, such as 1.25 of a

tone. Consequently, while an understanding of modern western music theory is given, it is only partially relevant.

Tuning was only standardised during the 19th century (Haynes, 2002: 343). The non-standardisation of pitch effectively means that what one centre or region called an A would not necessarily have been the same pitch as another centre's A, even in the same country. Pitch has also changed throughout history (Haynes, 2002: xxxiv). In addition, on some instruments, pitches were probably not referred to using letter names, or the choice of pitches may have been random rather than intentional. Therefore, letter names will only be used when they are apparent in the sources, such as the organ pipe treatises, and occasionally for clarification purposes. There are two systems of pitch notation: The Helmholtz system and Scientific Pitch Notation. This book will use the Scientific Pitch Notation when giving acoustically tested frequencies, and to separate this from those which are discussing the letter names given in sources from the period, which will be given using the Helmholtz system.

Early medieval music theory: a brief introduction

Most of the medieval writings about music are in music treatises, which were teaching manuals for *musica* taught in monasteries and cathedral schools (Baumann and Hagg, 1990: 199). From the ninth century, one of the central sources to be recopied during the Middle Ages was Boethius' (AD 477-524) five books *De institutione musica*, which, particularly in book one, contain acoustical knowledge of antiquity and served as the foundation for introductory acoustical definitions in numerous treatises (Baumann and Hagg, 1990: 199). Many subsequent theorists based corresponding chapters on Boethius (Baumann and Hagg, 1990: 199). Pythagoras (570-495 BC) is believed to have discovered the proportions of the intervals by observing the sounds of hammers of different sizes at a forge (Baumann and Hagg, 1990: 199). Boethius valued reason above the senses and often assessed the notes mathematically (Baumann and Hagg, 1990: 201). These concepts must be considered when

Table 1.1: The intervals and the number of semitones that comprise them for major and perfect intervals. Example letter names (starting from C) are given. (There are seven different letters used to notate music in modern western music theory (A-G), after which the sequence repeats).

Relatable modern interval names in modern western music theory	Number of semitones	Example letter names (in terms of modern western music theory, starting on C)
Major second (a tone)	2	D
Major third	4	E
Perfect fourth	5	F
Perfect fifth	7	G
Major sixth	9	A
Major seventh	11	B
Perfect octave	12	C

studying tunings of instruments such as the organ, which may have used such principles, and therefore, the notes may have suited the mathematical Pythagorean ratios on which the music was based. Vitruvius defines the effects of sound reflections, which indicates some people had an understanding of the nature of sound produced by wind instruments (Baumann and Haggh, 1990: 202).

The monochord, designed according to the legend of Pythagoras, was a theoretical tool. It was used to determine the ratios of the scales, and was used continuously from the classical Greek period through the Middle Ages to the Renaissance (Montagu, 1976: 14). The theories of Pythagoras and Boethius established themes in acoustics that were revisited and addressed through observation and experimentation after the early medieval period in England in works by Galileo (1564-1642), Marsenne (1588-1648), Descartes (1596-1650), Huygens (1629-1695), Newton (1643-1727), Euler (1707-1783), Bernoulli (1700-1782) and Fourier (1768-1830) (Bannan, 2017: 3). The continued interest and development of these ideas into early modern times emphasises their influence, which we may speculate was also felt in limited circles in early medieval English society.

Early medieval notated music in England

While it is not the focus of this book, a brief understanding of music notation puts the work into context. During the early medieval period, music started being written down, but only a small amount was notated. Reliance was on memory with only occasional notes for reminding purposes. Early medieval notation was non-diastematic, so singers needed to memorise much of the chant they performed (Page, 1981: 296). How and exactly when music notation came into England is unknown. The earliest known music notation dates from the 10th century, but there are two possible pieces of music notation from the eighth century: the *Durham Cassiodorus* (Durham, Cathedral Library, MS.B.II.30) and *Tiberius Bede* (London, British Library, Cotton Tiberius C.II) (Haines, 2008). Scholars such as Rankin (1984: 97) suggest music notation reached England during the ninth century from northern France, but that music-writing did not become established in England until the mid-10th century when contacts between England and the continent facilitated such techniques. The level of music notation in the Winchester Troper suggests musical notation was well established in Winchester by AD 1000, although the people writing the music were in ecclesiastical institutions, meaning musical notation was potentially church knowledge (Rankin, 1984: 98).