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Technical Report: The fish bone from St. John's Triangle, Cambridge (site code SJT07)

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Summary

This report presents an analysis of the fish bones from St. John's Triangle, Cambridge. This assemblage comprised sieved and hand collected bone from phases dating from the 2/3rd centuries through to the 19/20th centuries AD. Most of the material was from the 16th, late 16th and early 17th century phases. The identifiable assemblage was of moderate size, but broad changes through time can be seen and are consistent with general English trends through the medieval and early modern period, namely a shift towards increasing use of marine resources through time. The late 16th and early 17th century deposits are dominated by remains of large cod, which were imported to the site as a prepared and preserved foodstuff. These phases also feature several thousand large cod family rays and spines, which are an unusual deposit and which most likely represent the remains of dozens of large, preserved cod. A few finds of cod pre-date the late 16th century and suggest small quantities of fresh, whole cod were being consumed alongside some preserved imports, but prior to the late 16th century, cod and cod family fish were a minor component of the diet.

KEYWORDS: CAMBRIDGE, FISH BONES, ZOOARCHAEOLOGY, MEDIEVAL

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The fish bone from St. John's Triangle, Cambridge (site code SJT07)

Introduction

This report details the analysis of 773 identified fish bones from sieved and hand collected features excavated at St. John's Triangle, Cambridge. These bones date from the 2nd or 3rd century AD to the 19th or 20th century, but the majority of the identified bone dates from the early post-medieval period. The fish could have been caught in the River Cam, which runs through Cambridge and joins the River Great Ouse just south of Ely, before flowing out to the North Sea at King's Lynn, or they could have been caught in the North Sea and imported fresh, lightly cured for eating within a few days, or preserved for long-term storage.

Fish bones from 16 separately dated phases were recovered, and within each phase, a variety of context types were found. Table 1 summarises the numbers of bones identified from each phase, in order to provide an indication of the types of conclusions that could be drawn from the site. As can be seen, most of the identified bone from sieved contexts was found in contexts dating either broadly to the 16th century, or more precisely to the late 16th century. The identified bone from the hand collected fraction was primarily from the early 17th century phase, the late 16th century phase and the broadly dated 16th century phase. It will therefore be possible to discuss detailed information about fish species, sizes, likely origin and possible fishing methods for these 16th and 17th century features, but all other phases have far fewer bones and therefore the conclusions that can be drawn from them are more simplistic. Broad comparisons are possible from the 2/3rd century through to the 19/20th century using both the hand collected and sieved datasets. These will be used to explore basic temporal changes including fish species present, their sizes, and any changes to local (freshwater) river systems or long distance trade networks. Table 1 summarises the context types found at St. John's Triangle. Each phase generally has only one predominant context type, and pit fills dominate the assemblage. Context type variation will be considered when necessary – i.e. for the large 16th century phase, but much of the variation found at the site will likely be chronological rather than related to differences in context functionality.

Hand collected fish bones are notoriously biased towards the larger elements from larger species (Wheeler and Jones 1989), but they can still reveal information about the cod family fish (some of which tend to be of substantial size), and importantly, any butchery patterning can reveal information about fish processing, preservation and fish trade. The medieval trade in cod and cod family fish is well known both historically and archaeologically (Barrett 1997; Perdikaris 1999; Enghoff 2000; Harland *et al.* 2008). Fish were caught in Northern European waters, air dried or salted, and then imported throughout Europe; the resulting product went by several names including 'stockfish', and it could be kept for several years. It can be recognised archaeologically because of the typical element patterning, butchery marks and fish sizes involved. Any evidence for the consumption of prepared cod and cod family fish at St. John's Triangle will be discussed in detail. The herring trade was also well known historically from English ports on the North Sea, including Great Yarmouth and King's Lynn, and although it is more difficult to recognise and distinguish preserved herring from those consumed fresh, the historical and archaeological evidence for this trade will also be discussed.

Methods

This assemblage was recorded using the York System, an Access database utility designed for recording zooarchaeological assemblages, as well as the extensive reference material available in the Department of Archaeology, University of York. The recording protocol is fully detailed in Harland *et al.* (2003). Briefly, this entails the detailed recording of the 18

most commonly occurring and easily identified elements, termed quantification code (QC) 1. For each of these, the element, species, approximate size, side, fragmentation, texture, weight and any modifications are recorded in detail. Fish vertebrae (QC2) are recorded in more limited fashion, with counts, element and species recorded. Some elements are unusual and particularly diagnostic, like otoliths, and are fully recorded (QC4). The final category of material (QC0), includes elements not routinely identified as well as unidentifiable material. Elements that are from very unusual species, or that are butchered, are recorded in detail even if not from the QC1 category. Data analysis involved structured database queries, as well as manipulation using Excel.

It became apparent during initial assessment that some of the larger cod were likely imported as prepared, preserved fish. When large cod and related species are preserved by air drying or salting, often most of the head elements are removed and left at the production site. Archaeologically, the imported product is often only represented by vertebrae and a few selected appendicular elements (those from the back of the head including the cleithra). Because of the lack of cranial elements, it was necessary to record fish sizes for all cod vertebrae, even though this is not usually done.

This assemblage was also unusual in containing very large quantities of gadid fin rays and spines, which are not normally identified. These were recorded as 'unidentified' but a note was made in the database of their probable identification. For this reason the unidentified material from the 2-4mm fraction was counted and weighted, as a substantial portion of this comprised these highly fragmented rays and spines; this fraction would usually remain uncounted and unweighed in a more normal assemblage. A small number of fragments from the <2mm fraction were identified, even though again this is not routine procedure – primarily because very few fragments are ever identifiable from this fraction. These were almost entirely from context 2087, sample 202, and included the only identification of sprat at St. John's Triangle.

The minimum number of individuals (MNI) statistic is not usually calculated for small assemblages because of its many biases and distortions (Reitz and Wing 1999; O'Connor 2000), but the two largest contexts warrant attention as they are large, discrete deposits. These include context 4031 from the late 16th century, recovered both by sieving and by hand collection, and context 4023 from the early 17th century, only recovered by hand collection. In order to approximate the minimum number of fish found in each of these contexts, element counts for each species were examined. Using estimated fish sizes, fragmentation patterns, and taking into account left and right siding for elements occurring in pairs, the most frequently occurring element was determined, and this was used as the MNI figure.

The complete archive has been submitted to the excavators as both an Access file and as simple text files containing the same data. These are also kept on file in the Fishlab at the University of York.

Preservation

Bone condition was overall good, with a moderately high proportion of identifiable material, and overall good or fair texture and completeness (Table 2). The sieved material tended to be better preserved both regards bone texture and bone completeness than the hand collected material.

A surprisingly high number of modifications were noted throughout the assemblage (Table 2). Burnt bone was observed as both calcined and charred on a variety of species. Only one instance of carnivore gnawing was noted, on a cod bone from the 16th century, but plenty of crushed specimens were noted throughout many phases. Several different species showed evidence of crushing. On the smaller species, like eel, herring, perch or carp family fish,

these probably were the result of chewing during consumption. All of the crushed bones were vertebrae, which makes them very likely to have been crushed during chewing. Some of this material may therefore have been cess, but as no acid etching was observed in the entire assemblage, the crushing may also have originated from the cooking process or from depositional factors. The larger species, like flatfish or ling may have been crushed during chewing but were unlikely to have passed through the human gut owing to their large size. These modifications indicate these were most likely food remains, some burnt from cooking fires, some crushed by cooking or chewing, and at least one later scavenged. Three 16th century eel vertebrae were stained green (from pit fill 1132), as were two late 16th century large gadid ribs and a cod vertebra (from pit fill 4031).

Fresh breakage was observed on 11 very large cod and ling bones from the 16th and 17th centuries, indicating that excavation and post-excavation damage was minimal to most of the assemblage, but that these larger bones suffered slightly during excavation or cleaning and drying.

Results

Species

A total of 773 fish bones were identified to species or species group at St. John's Triangle, with 11 of these from <2mm sieved material, 635 from >2mm sieved material and a further 127 collected by hand (Table 3). Cod, herring and eel were the most common species in the sieved assemblage, accounting for almost 80% of all identifications, and the hand collected material was again dominated by cod to the exclusion of most other species (full taxonomic names are provided in Table 8). Over 6,800 large cod family rays and spines were counted as 'unidentified fish' but were separately noted; some of these are illustrated in Figure 1. These were found in hand collected and sieved 16th century, late 16th century and early 17th century phases and comprise almost all of the unidentified QC0 fish bones from these phases. When these large quantities of large cod family rays and spines are considered, cod and cod family fish can be seen to dominate the assemblage. A wide range of secondary fish taxa were recorded and quantified, including, in rank order, carp family, herring family and sprat in the <2mm fraction; carp family, halibut family, cod family, herring family, plaice, whiting, perch, roach, pike, ray family, Atlantic mackerel, burbot, flatfish, gurnard family, tench, turbot family, mackerel family, European anchovy, halibut and salmon and trout family in the >2mm fraction; and ling, pike, halibut family, herring, cod family, conger eel, carp family, pollack?, whiting, Atlantic mackerel and plaice in the hand collected fraction.

Despite the predominance of 16th and 17th century fish bones, it is still possible to examine some broad changes through time. Eel was the only taxa to be identified in the 2/3rd century phase, indicating some local exploitation of fresh water river systems. The lack of other fish in this phase could indicate an avoidance of fish as a foodstuff; comparison with the mammal and bird assemblages could help to understand this early material. The small 10th to 12th century phases feature eel, herring and carp family fish, as is to be expected given the date of this material. At this time in many English sites, local water sources were the main source of fish for consumption, with some fish, like herring and flatfish, starting to be brought from marine or estuarine sources (Barrett *et al.* 2004b; Barrett *et al.* 2004a). By the 12th to 15th centuries, a greater diversity of fish was observed, despite the small sample sizes: cod and ling appear for the first time at St. John's Triangle, and when taken together with the ray family remains, they indicate greater exploitation of marine resources through this period. The large 16th century phases continue these trends. A much greater diversity of fish remains was found, reflecting both the large quantity of bones found, as well as the general trends towards increased marine exploitation compared to the early centuries of the second millennium AD. The 16th century sieved assemblage contains a variety of species, including herring family (35%), eel (25%), carp family (22%), various flatfish (11%) and several other

marine and freshwater species. What is unusual about this phase, however, is the lack of cod family fish. Cod and whiting were both observed in the sieved assemblage, but at only 3% of all identified fish. When contrasted with the late 16th century sieved phase, this absence is even more remarkable. The late 16th century material is dominated by cod, at 82% of identified fish, with small quantities of eel (7%), herring (7%), carp family (3%) and others. The hand collected 16th century material has results that are more typical of the period. The 16th century phase is dominated by cod (77%) and ling (9%), with a few other species, but the sample size is very small and thus may not be representative. The larger late 16th century phase is mostly cod (94%), as is the early 17th century phase (90%). Why so few cod and cod family in the 16th century sieved material? Even the thousands of cod family rays and spines counted but recorded as 'unidentified' were not found in this fraction. This difference is also unlikely to result from a taphonomic or preservation bias, as there was no substantial difference between phases. Context types were similar between phases as well, with both predominantly from pit fills, but site function may have changed between the 16th and late 16th century phases. It remains a possibility that these differences were due to dietary and budgetary preferences, as well as possible changes in availability of fresh and imported preserved fish between these phases.

The ubiquity of eel, herring and freshwater fish like the carp family might suggest that St. John's Triangle represents the remains from modest meals that were not high status dining. Eel tends to be a commonly recovered species throughout most English medieval sites (Serjeantson and Woolgar 2006) and they were likely extremely common in the Cambridgeshire fenland and in the River Great Ouse and the River Cam (Pinder *et al.* 1997; Fort 2003). Their relative absence from nearby medieval and later sites in Cambridge, including Grand Arcade and Hostel Yard, Corpus, was thought to relate to the relatively high status nature of these assemblages (Harland 2008a; Harland 2008b), implying St. John's Triangle does not share this higher status.

Two specimens are unusual for British assemblages. One European anchovy caudal vertebra was identified from a late 18th century context, from a fish of about 20-25cm total length, and one sprat dentary from a fish of less than 15cm total length was found in a 16th century context. The European anchovy is relatively common around British waters (Froese and Pauly 2007), yet was rarely exploited in the past. Sprats may often be missed because of their small size and similarity to other herring family fish, yet again they are common around the British Isles (Froese and Pauly 2007). Both unusual species may represent bycatch, or stomach contents from one of the larger species.

All of the freshwater fish found at St. John's Triangle could have been caught in the River Great Ouse system. This includes the River Cam, which flows through Cambridge and joins the Great Ouse just south of Ely (Pinder *et al.* 1997). The burbot is a freshwater cod family fish, now very probably extinct in British waters (Buczacki 2002), and along with some of the carp family fish, it is susceptible to riverine pollution (Jones 1988). The two identifications made in the 14-15th century phase indicate local freshwater exploitation, but give little indication of changes through time. However, at both Hostel Yard, Corpus Christi and Grand Arcade, burbot declined through time, probably as a direct result of declining water conditions in the local area.

The marine fish probably came from the southern North Sea region. Herring and cod family fish may have been imported as prepared fish, with the latter possibly from the northern North Sea or Scandinavian waters and traded through a merchant centre like King's Lynn. From there, the marine fish could have reached Cambridge by water, shipped on the Great Ouse and subsequently the River Cam. Most marine fish could probably have been imported to Cambridge quickly enough to not require preservation, but herring are very quick to spoil so may have required a short-term cure (Cutting 1955). Herring migrate around the North Sea, reaching the southern region by the autumn; this would make them a seasonal resource.

Element and butchery patterning will examine the evidence for trade and preservation of marine fish in greater detail.

Fish sizes

All of the cranial elements were sized during identification, as were the cod vertebrae, thus providing an indication of changes in size through time (Table 4). Cod and cod family fish tend to be of large size if imported as preserved fish. Cod from the late 16th century sieved contexts, and the late 16th and early 17th century hand collected contexts were all of at least 80cm total length, with a significant proportion over 100cm in length. The thousands of cod family rays and spines from these contexts were consistent with fish of this size. These could represent cod and cod family fish imported as a preserved foodstuff. Element patterning, examined below, will help to ascertain if these fish were arrived ready-prepared or whole and fresh.

Cod remains from other sieved deposits represent a wider range of sizes. One specimen of 50-80cm total length was found in the 14-15th century phase, while one of 15-30cm and two of 80-100cm total length were recorded from the 16th century phase. These are less likely to represent cod traded as a preserved product, and probably indicate cod were being imported fresh and whole from the sea, although the two larger specimens may indicate some preserved cod was arriving at St. John's Triangle in the 16th century. However, the small quantity of cod in this phase suggests it was by no means a staple food. Very large cod of over 100cm total length were found in two early hand collected phases dating from the 12-14th and 14-15th centuries. These could represent early imports of a preserved product, and element and butchery patterning will help to clarify this possibility (below). The hand collected cod from the 15th and 16th century phases indicate a range of sizes were present, some of small size and thus likely to have been brought to the site fresh and whole. The one hand collected ling from the 15-16th century phase was likely a preserved import, as ling of this large size are unlikely to have been found in nearby regions of the North Sea (Froese and Pauly 2007).

Other fish species are represented by a wide variety of sizes. Eel remains represent fish of 15 to 80cm total length, with no patterning through time, while the one hand collected conger eel was from a very large individual. Other freshwater fish, like the carp family, indicate fish of less than 15cm to fish of up to 50cm total length were being deposited at the site. The smallest of these may have been the stomach contents of the large fish, including pike, as their small size would make them less desirable for human consumption. They may have been used as bait fish as well.

The herring remains found represent fish of 15 to 30cm total length, the expected range for herring from the medieval and later period. The few flatfish found represent a wide range of sizes from 15 to 50cm in length, suggesting no particular size preferences or changes through time. The four whiting bones that could be sized, all from the probably or definite 16th century phases, represent fish of 15 to 50cm total length. These were a common foodstuff at that time (Serjeantson and Woolgar 2006) – but found in small quantities here – and would have been brought from the sea as fresh and whole fish.

Element distribution

Although many of the fish found at St. John's Triangle were deposited in their entirety, as seen by a wide variety of head and body elements, it is immediately apparent that cod are exceptional (Table 5). The late 16th century sieved cod comprise 153 vertebrae from the back of the body and the tail, 37 cleithra, and various posttemporals, scapulas and supracleithra. These four elements are found at the back of the head, in the appendicular or 'shoulder' region, and together comprise a distinctive suite of elements used as indicators of the cod preservation process. When cod and related species, including ling and haddock, are preserved by air drying or by a combination of salting and drying, the head and some of the anterior vertebrae are removed and discarded at the production site. The remaining elements

are exported with the preserved flesh and end up discarded during cooking or consumption. These include the cleithra and associated elements from the appendicular region, as well as the more posterior vertebrae remaining elements. When no other head elements are found, aside from the appendicular region, and the remains are from larger fish, it is most likely these remains were once preserved, imported fish. This can be confirmed by distinctive butchery patterning, as discussed below. The distinctive patterning observed in the sieved late 16th phase therefore indicates these were preserved, imported fish.

Further proof of this is provided by a series of articulated cod bones excavated separately from the late 16th century phase (context 4031, catalogue <1985>) and photographed in situ. The photo clearly shows two separate series of articulated vertebrae, but both were bagged together. The 26 identifiable vertebrae were all from cod of about 95-100cm in length, and they are therefore very difficult to separate. A further 541 large gadid spines and rays were found in association with these articulated vertebrae. Based on the picture, these likely represent the caudal (tail) vertebrae from two separate individuals. This is, however, not definite and there remains the possibility that these only represent one fish.

The three cod bones from the 16th century sieved deposits comprise a small scapula and two large vertebrae, and thus could represent either fresh or preserved consumption. However, the hand collected assemblage from both the late 16th and early 17th century phases contains only those elements associated with consumption of preserved cod. Hand collected cod were also found in the 16th century phase, but here, elements from the cranium were found alongside appendicular elements and vertebrae; these could represent both imported preserved cod and some consumption of fresh cod. Other hand collected phases with cod contain only small numbers of elements, making it difficult to determine if they were likely eaten fresh or as a preserved foodstuff. However, the 15th century phase contains only cranial elements, and thus were likely eaten fresh.

The few ling remains found were consistent with these being imported, preserved fish. These were found in very small quantities from the 15-16th century onwards.

Other fish species were much more likely to have been deposited in their entirety, suggesting they had been consumed when fresh. Herring can be butchered and salted in barrels for long-term storage, but these fish often are missing their cleithra and supracleithra (Enghoff 1999), which was not the case here. Herring will spoil very quickly because of their oily nature, but if lightly salted, without any butchery, they will keep for a short amount of time permitting transport inland. This was most likely the case with the herring from St. John's Triangle. They were probably caught in the North Sea and landed at a specialised fishing port like Great Yarmouth or Cromer, before being traded to King's Lynn (Childs 2000; Robinson 2000) and shipped up the Great Ouse river system.

MNI

The minimum number of individuals statistic was calculated for the late 16th century context 4031 and the early 17th century context 4023, both part of pit feature 400 (Table 6). These values take into account element quantities, fragmentation and fish sizes. Despite context 4031 containing just under 7000 bone fragments, the minimum number of fish was actually quite small: 21 fish in total, comprising 12 cod, one eel, one herring, one carp family, one tench, one cod family, one gurnard family, one Atlantic mackerel, one perch and one plaice. However, the thousands of cod family rays and spines are impossible to factor in to this MNI quantification, as it is very difficult to distinguish the various fins and quantify them separately, but these likely represent at least a few dozen large cod. Context 4023 also contained only a small number of species: 14 fish comprising seven cod, one herring, one carp family, one pike, one ling, one pollack?, one halibut family and one plaice. This context also contained several hundred cod family rays and spines that were difficult to quantify, and which probably accounted for more than just the seven cod quantified by MNI.

The use of the MNI statistic inflates the proportions of the minor species, making them appear as though they contributed more to the diet; cod was the predominant species deposited in this feature and it would have accounted for almost all of the fish consumed in these contexts.

Butchery

A total of 68 butchery marks were recorded, one on a pollack? vertebra, 13 on cod family ribs and rays, and the rest on various cod elements (Figures 2, 3 and 4). These were only predominantly found on the larger fish, most of which were at least 80cm in length, and many can be linked to butchery during preservation. When the head and anterior vertebrae are removed and discarded at the production site, butchery marks are often left on the appendicular elements and the vertebrae, and these are then found at the consumption site – which explains many of these butchery marks from St. John's Triangle. The exception is a cod dentary from the 15th century, from a fish of 50-80cm total length; this was probably butchered to aid hook removal.

Changes in butchery strategies through time may suggest different methods of preservation were being used, or cod was being sourced from different regions. In the 16th century phase, butchery marks were noted on three appendicular elements and three vertebrae. Most of these were small knife marks and none of the vertebrae were chopped. In the late 16th century phase, chop marks were much more common, on both the appendicular and vertebral elements. In particular, butchery marks were found on several of the vertebra indicating they had been chopped through in the sagittal plane, as though dividing fish into left and right sides. The two anterior articulated vertebrae from the complete tail skeleton in context 4031 (catalogue <1985>) were butchered, which provides an insight into this process. These were the two vertebrae at the front of this articulated vertebral sequence, one chopped through in the sagittal plane, on the right side but slightly angled, and the other containing a small knife mark on the right anterior articular surface, in line with the chop mark. This indicates that the main body of the cod may have been split into left and right sides, but this was not done at the tail region: instead, at this point the chop angled to one side, stopping the division into sides, thus leaving the tail in one piece.

The trend towards sagittal chopping continued into the early 17th century phase. Sagittal chopping may have been done during the preservation process, if the fish was separated into two halves to ease drying. Or, it could have been done during the cooking process to create smaller portions of food – but it would have been much easier to subdivide the fish into steaks using a transverse chop. Similar sagittal chop marks have been observed on other cod from Cambridge, as well as from medieval and later York. Isotopic testing of $\delta^{15}N$ and $\delta^{13}C$ is currently in progress to determine where these fish were likely caught and preserved, and whether or not sagittal chopping indicates a particular regional source for this preservation method (following Barrett *et al.* 2008).

A single very large butchered cod cleithrum from the 12-14th century indicates preserved cod were probably being imported at this early date. However, the small size of the assemblage from this phase makes it difficult to interpret these results.

The numerous butchered cod family ribs and rays from the 16th and late 16th century phases are unusual, in that butchery marks are rarely noted on these elements. They could have been caused during cooking preservation or consumption, as these bony parts would not have been eaten.

Summary and conclusions

The fish remains from St. John's Triangle comprise almost two millennia of deposits, and contain a range of freshwater and marine species. In the earlier phases, which were of small size, the emphasis was on locally caught freshwater species, including eel and carp family fish. Herring were the first marine species to be exploited in any quantity, first appearing probably in the 10th to 12th centuries. Between the 12th and 15th centuries, a wider range of fish species were consumed, including several from marine habitats. The first large phase, from the 16th century, suggests a wide range of species were consumed, including both local freshwater species like eel and carp family fish, as well as herring and flatfish. The lack of cod family fish in this phase is surprising and may indicate a lack of resources for purchasing such fish, or a preference towards other species. However, cod become the dominant species from the late 16th century onwards, and these were likely imported as a preserved, traded foodstuff.

The remains from pit 400, comprising contexts 4023 and 4031, were unusual and warrant special mention. During excavation, the basal fill of this pit (context 4031) was observed to contain many fish remains still in articulation but without heads; one of these was separately excavated and proved to comprise one or two cod tails with the foremost vertebrae displaying signs of butchery. These were situated mainly on the base of the pit. Context 4023 overlay this basal layer and again many fish bones were noted during excavation, along with other animal remains. Numerous finds of a generally domestic nature were found in this pit, although there is some suggestion that it may have been associated with an inn or tavern (Newman 2008). The lower layer dated to the late 16th century and the upper layer to the early 17th century. The contents were consistent between phases and suggested continuity in consumption patterns. Preserved cod was the fish of choice in these deposits.

The freshwater species were probably caught with hook and line, or with fish traps or nets, and some of the smallest fish may have been bait or stomach contents of the larger ones. The marine fish were probably caught by long lining (particularly the cod and marine cod family fish) or by netting or with hook and line. A single metal artefact from a 10-11th century context might have been a fishhook, with dimensions of 24mm long by 12mm wide (Newman 2008). Based on comparisons from contemporary and later medieval British sites, this hook would have been quite small and thus not suitable for any large freshwater or marine fish (Riddler and Walton Rogers 2006). However, it could have been used for fishing smaller freshwater species, including the eel or carp family fish found in this phase.

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Tables

Table 1: Summary of phases, bone quantities and context types

Phase	<2mm	>2mm			Hand collected		
	Identified	Identified	Unidentified	Total	Identified	Unidentified	Total
2/3rd		1		1			
10-11th		6	12	18			
10-12th		12	3	15		1	1
12-14th					1		1
12th		2		2			
13th		7	3	10			
14-15th		19	17	36	1	1	2
15-16th					1		1
15th		1	2	3	4	13	17
16th	11	299	395	694	22	208	230
Probable 16th					2	5	7
Late 16th		276	6110	6386	36	546	582
Early 17th					58	824	882
Early 18th		1		1			
Late 18th		11	37	48			
19/20th					2		2
Total	11	635	6579	7214	127	1598	1725

Phase	Context description	<2mm	>2mm	Hand collected
2/3rd	Pit fill, domestic dumps		1	
10-11th	Pit fill		18	
10-12th	Pit fill, possibly cess		15	1
12-14th	Garden soil			1
12th	Layer		2	
13th	Pit fill, possibly cess		10	
14-15th	Pit fill		36	2
15th	Layer			4
	Layer, possibly floor of workshop/forge		3	1
	Pit fill			12
15-16th	Garden soil with tanning waste			1
16th	Layer			2
	Levelling			8
	Oven fill		130	1
	Pit fill	11	564	214
	Pit fill, domestic dumps			1
	Pit fill, probably industrial			2
	Robber fill			2
Probable 16th	Pit fill			2
	Pit fill, domestic dumps			5
Late 16th	Pit fill, rich in articulated fish remains		6386	582
Early 17th	Pit fill, rich in animal bone			882
Early 18th	Pit fill		1	
Late 18th	Backfilling		48	
19/20th	Mixed, associated with Trinity College			2

Table 2: Taphonomy data
Surface texture of QC1 elements

Recovery	Phase	Good	Fair
>2mm	10-11th	2	
	10-12th	1	
	13th	3	1
	14-15th		1
	15th	1	
	16th	58	11
	Late 16th	54	24
	Late 18th	1	
	Total	120	37
Hand collection	12-14th	1	
	15th	1	3
	16th	5	5
	Early 17th	20	15
	Late 16th	4	4
	Probable 16th		1
	Total	31	28

Percent completeness, QC1 elements

Recovery	Phase	1-20%	20-40%	40-60%	60-80%	80-100%	Total
>2mm	10-11th					2	2
	10-12th					1	1
	13th		1	3			4
	14-15th		1				1
	15th				1		1
	16th	1	10	12	17	29	69
	Late 16th	10	19	21	14	14	78
	Late 18th					1	1
	Total	11	31	36	32	47	157
Hand collection	12-14th	1					1
	15th	1		2	1		4
	16th		3	2	3	2	10
	Probable 16th					1	1
	Late 16th		3	1	3	1	8
	Early 17th	3	14	4	8	6	35
	Total	5	20	9	15	10	59

Quantities of diagnostic elements per phase

Phase	>2mm					Hand collected			
	QC1	QC2	QC4	QC0	Total	QC1	QC2	QC0	Total
2/3rd		1			1				
10-11th	2	4		12	18				
10-12th	1	11		3	15			1	1
12-14th						1			1
12th		2			2				
13th	4	3		3	10				
14-15th	1	18		17	36		1	1	2
15-16th							1		1
15th	1			2	3	4		13	17
16th	69	226	4	395	694	10	12	208	230

Probable 16th						1	1	5	7
Late 16th	78	198		6110	6386	8	28	546	582
Early 17th						35	23	824	882
Early 18th		1			1				
Late 18th	1	9	1	37	48				
19/20th							2		2
Total	157	473	5	6579	7214	59	68	1598	1725

Modification	Recovery	Taxa	Phase								
			10-11th	10-12th	13th	14-15th	15-16th	16th	Late 16th	Early 17th	Late 18th
Calcined	>2mm	Atlantic Herring							1		
		Burbot				1					
		Unidentified							4		
Charred	>2mm	Atlantic Herring						1			
		Tench							1		
		Pike			1						
		Gurnard Family							1		
		Halibut Family		1				1			
		Unidentified			1	3			4		
	Hand collected	Cod								1	
Carnivore gnawing	Hand collected	Cod						1			
Crushed	<2mm	Carp Family						1			
	>2mm	Eel	1	3	1	1		23	6		1
		Atlantic Herring		1				9	2		1
		Carp Family						2	1		1
		Whiting						1			
		Perch						1	1		
		Mackerel Family						1			
		Atlantic Mackerel						2	1		
		Flatfish Order						1			
		Halibut Family						6			
		Unidentified									1
	Hand collected	Ling					1				
Total modifications			1	5	3	5	1	50	22	1	4
% of total bone modified per phase			5.6%	31.3%	30.0%	13.2%	100%	5.3%	0.3%	0.1%	8.9%

Table 3: Number of identified specimens (NISP) by species (p=present but QC0)

<2mm sieving		
Family	Taxa	16th
Clupeidae	Herring Family	3
	Sprat	1
Cyprinidae	Carp Family	7
Total <2mm id'd		11

>2mm sieving												
Family	Taxa	2/3rd	10-11th	10-12th	12th	13th	14-15th	15th	16th	Late 16th	Early 18th	Late 18th
Rajidae	Ray Family						1	1	0.3%			1

Anguillidae	Eel	1	5	5		1	6	1	74	24.7%	20	7.2%		3
Clupeidae	Herring Family					2			5	1.7%			1	1
	Atlantic Herring			5			7		100	33.4%	18	6.5%		3
Engraulidae	European Anchovy													1
Cyprinidae	Carp Family		1	1	2	1	1		61	20.4%	8	2.9%		1
	Roach								5	1.7%				
	Tench					1					1	0.4%		
Esocidae	Pike					1			3	1.0%				
Salmonidae	Salmon & Trout Family						1							
Gadidae	Cod Family								p		p			
	Burbot						2							
	Cod						1		3	1.0%	226	81.9%		
	Whiting								6	2.0%				
Triglidae	Gurnard Family								1	0.3%	p			
Percidae	Perch								4	1.3%	1	0.4%		
Scombridae	Mackerel Family								1	0.3%				
	Atlantic Mackerel								2	0.7%	1	0.4%		
Flatfish Order									1	0.3%				1
Bothidae (Scoph.)	Turbot Family								2	0.7%				
Pleuro-nectidae	Halibut Family			1		1			24	8.0%				
	Halibut								1	0.3%				
	Plaice								5	1.7%	1	0.4%		
Total >2mm id'd		1	6	12	2	7	19	1	299	100%	276	100%	1	11
	Unidentified		12	3		3	17	2	395		6110			37
Total >2mm		1	18	15	2	10	36	3	694		6386		1	48

Hand collection															
Family	Taxa	10-12th	12-14th	14-15th	15-16th	15th	16th		Prob. 16th	Late 16th		Early 17th		19/20th
Congridae	Conger Eel					1								
Clupeidae	Atlantic Herring									1	2.8%	1	1.7%	
Cyprinidae	Carp Family											1	1.7%	
Esocidae	Pike						1	4.5%				p		1
Gadidae	Cod Family						p			1	2.8%			
	Cod		1	1		3	17	77.3%		34	94.4%	52	89.7%	
	Ling				1		2	9.1%	1			1	1.7%	
	Pollack?											1	1.7%	
	Whiting								1					
Scombridae	Atlantic Mackerel						1	4.5%						
Pleuro-nectidae	Halibut Family						1	4.5%				1	1.7%	1
	Plaice											1	1.7%	
Total hand collection id'd			1	1	1	4	22	100%	2	36	100%	58	100%	2
	Unidentified	1		1		13	208		5	546		824		
Total hand collection		1	1	2	1	17	230		7	582		882		2

Table 4: Fish size summary

>2mm sieving									
Taxa	Total length	10-11th	10-12th	13th	14-15th	15th	16th	Late 16th	Late 18th
Eel	15-30cm							1	
	30-50cm	2				1	5		
	50-80cm						1		1
Atlantic Herring	15-30cm						40	2	
Carp Family	<15cm		1	1			5		
	15-30cm						1		
	30-50cm						1		
Roach	<15cm						3		
	15-30cm						2		
Tench	<15cm			1				1	
Pike	30-50cm			1					
Cod Family	80-100cm						1		
Burbot	30-50cm				1				
Cod	15-30cm						1		
	50-80cm				1				
	80-100cm						2	115	
	>1000mm							104	
Whiting	15-30cm						2		
	30-50cm						1		
Halibut Family	15-30cm						1		
	30-50cm			1					
Halibut	30-50cm						1		
Plaice	15-30cm						4		
	30-50cm						1	1	

Taxa	Total length	12-14th	14-15th	15-16th	15th	16th	Prob. 16th	Late 16th	Early 17th
Conger Eel	>100cm				1				
Atlantic Herring	15-30cm							1	1
Carp Family	15-30cm								1
Pike	30-50cm								1
	50-80cm					1			
Cod Family	80-100cm					1		1	
Cod	30-50cm				1				
	50-80cm				1	3			
	80-100cm				1	6		29	21
	>100cm	1	1			8		5	27
Ling	>100cm			1		2			1
Whiting	15-30cm						1		
Plaice	15-30cm								1

Table 5: Element quantification

>2mm sieving												
Taxa	Element	2/3rd	10-11th	10-12th	12th	13th	14-15th	15th	16th	Late 16th	Early 18th	Late 18th
Ray Family	Dermal Denticle								1			1
	Vertebra						1					
Eel	Ceratohyal		1					1	1			
	Cleithrum		1						2	1		1
	Hyomandibular								1			
	Parasphenoid								1			
	Vomer								1			
	Abdominal Vertebra	1	1	4		1	1		40	12		1
	Caudal Vertebra		2	1			5		28	7		1
Herring Family	Ultimate Vertebra					1						
	Caudal Vertebra					1			5		1	1
Atlantic Herring	Articular								4	1		
	Basioccipital								1			
	Ceratohyal								3			
	Cleithrum								3			
	Dentary								3			
	Hyomandibular								4	1		
	Maxilla								6			
	Opercular								3			
	Otic Bulla								3			
	Parasphenoid								2			
	Posttemporal								3			
	Preopercular								4			
	Quadrate								2			
	Supracleithrum								1			
	Vomer								1			
	First Vertebra								3			
	Abdominal Vertebra			2			3		26	4		2
	Caudal Vertebra			3			4		28	12		1
European anchovy	Caudal Vertebra											1
Carp Family	Dentary			1					1			
	Infrapharyngeal					1			2			
	Opercular								1			
	Preopercular								3			
	Abdominal Vertebra				1				26	3		
	Caudal Vertebra				1		1		28	5		1
	Ultimate Vertebra		1									
Roach	Infrapharyngeal								5			
Tench	Infrapharyngeal					1				1		
Pike	Palatine					1						
	Abdominal Vertebra								3			
Salmon & Trout Family	Caudal Vertebra						1					
Cod Family	Branchiostegal									11		
	Rib								1	2		
Burbot	Abdominal Vert. Group 2						1					
	Caudal Vertebra Group 1						1					
Cod	Articular						1					
	Cleithrum									37		

	Posttemporal						11			
	Scapula					1	11			
	Supracleithrum						14			
	Caudal Vertebra Group 1						3			
	Caudal Vertebra Group 2					2	144			
	Penultimate Vertebra						3			
	Ultimate Vertebra						3			
Whiting	Articular					1				
	Posttemporal					1				
	Supracleithrum					1				
	Abdominal Vert. Group 3					1				
	Caudal Vertebra Group 1					1				
	Caudal Vertebra Group 2					1				
Gurnard Family	Caudal Vertebra					1				
Perch	Abdominal Vertebra						1			
	Caudal Vertebra					4				
Mackerel Family	Vertebra					1				
Atlantic Mackerel	Vertebra					2	1			
Flatfish Order	Caudal Vertebra					1				1
Turbot Family	Caudal Vertebra					2				
Halibut Family	Opercular					1				
	Posttemporal			1						
	Abdominal Vertebra					2				
	Caudal Vertebra		1			21				
Halibut	Vomer					1				
Plaice	Articular					1				
	Cleithrum						1			
	Opercular					1				
	Preopercular					2				
	Supracleithrum					1				

Hand collection										
Taxa	Element	12-14th	14-15th	15-16th	15th	16th	Prob. 16th	Late 16th	Early 17th	19/20th
Conger Eel	Dentary				1					
Atlantic Herring	Maxilla							1		
	Preopercular								1	
Carp Family	Opercular								1	
Pike	Dentary					1				
	Ectopterygoid								1	
	Caudal Vertebra									1
Cod Family	Branchiostegal					1				
	Caudal Vertebra Group 2							1		
Cod	Articular					1				
	Cleithrum	1				3		4	19	
	Dentary				1					
	Parasphenoid				2					
	Posttemporal					1		1	2	
	Preopercular					1				
	Scapula								2	
	Supracleithrum					2		2	8	
	Abdominal Vert. Group 1					1				
	Caudal Vertebra Group 1					2		1	2	
	Caudal Vertebra Group 2		1			6		24	19	

	Penultimate Vertebra			1		
	Ultimate Vertebra			1		
Ling	Cleithrum		1			
	Supracleithrum				1	
	Abdominal Vert. Group 1	1				
	Caudal Vertebra Group 1		1			
	Caudal Vertebra Group 2		1			
Pollack?	Caudal Vertebra Group 1				1	
Whiting	Cleithrum		1			
Atlantic Mackerel	Caudal Vertebra		1			
Halibut Family	Abdominal Vertebra		1		1	1
Plaice	Cleithrum				1	

Table 6: MNI quantification

Context 4031, late 16th century	No size	<15cm	30-50cm	80-100cm	>100cm
Eel	1				
Herring	1				
Carp Family	1				
Tench		1			
Cod Family	1				
Cod				3	9
Gurnard Family	1				
Perch	1				
Atlantic Mackerel	1				
Plaice			1		
Context 4023, early 17th century	**No size**	**15-30cm**	**30-50cm**	**80-100cm**	**>100cm**
Herring		1			
Carp Family		1			
Pike			1		
Cod				4	3
Ling					1
Pollack?	1				
Halibut Family	1				
Plaice		1			

These counts should be taken as approximations, given the inherent inaccuracies involved with any MNI calculations

Table 7: Butchery summary

Element	Description	Interpretation	Total length	Recovery
Pollack?, Early 17th century				
Caudal Vert. Group 1	Possibly pathological; very small knife mark on right ventral surface, sagittal plane	?	80-100cm or >100cm	Hc
Cod family, 16th century				
Rib	Chopped	Cooking or consumption	80-100cm	>2mm
Branchiostegal ray	Multiple series of small knife marks	Cooking or consumption	80-100cm	>2mm
Cod family, late 16th century				
Branchiostegal ray (x11)	Chopped	Cooking or consumption	>80cm	>2mm

Cod, 12-14th century				
Cleithrum	Chopped in approx. frontal plane, leaving only the dorsal tip; also two small knife marks adjacent to chop	Processing for preservation	>100cm	Hc
Cod, 15th century				
Dentary	Chopped through in sagittal plane just adjacent to central articulation	?Hook removal	50-80cm	Hc
Cod, 16th century				
Cleithrum	Chopped and cut in several places in frontal and sagittal planes	Processing for preservation	>100cm	Hc
Posttemporal	Series of small knife marks	Processing for preservation	>100cm	Hc
Supracleithrum	Small knife marks	Processing for preservation	80-100cm	Hc
Caudal Vert. Group 1	Small knife marks on right side, transverse plane; also left side, sagittal plane	Processing for preservation	80-100cm	Hc
Caudal Vert. Group 2	Small knife mark on left side, sagittal plane	Processing for preservation	>100cm	Hc
Caudal Vert. Group 2	Small knife marks on left and right sides, sagittal plane	Processing for preservation	>100cm	Hc
Cod, late 16th century				
Cleithrum (x3)	Chopped in frontal plane	Processing for preservation	80-100cm	>2mm
Cleithrum (x3)	Chopped in frontal plane	Processing for preservation	>100cm	>2mm
Cleithrum (x2)	Chopped obliquely in approx. sagittal plane	Processing for preservation	>100cm	>2mm
Cleithrum (x3)	Series of knife marks, oblique, in approx. sagittal plane	Probably processing for preservation, or cooking preparation	>100cm	>2mm
Posttemporal	Chopped	Processing for preservation	80-100cm	>2mm
Posttemporal (x2)	Chopped	Processing for preservation	>100cm	>2mm
Posttemporal	Chopped	Processing for preservation	>100cm	Hc
Posttemporal	Knife marks	Probably processing for preservation, or cooking preparation	>100cm	>2mm
Supracleithrum (x4)	Chopped	Probably processing for preservation, or cooking preparation	>100cm	>2mm
Caudal Vert. Group 1	Chopped in approx. sagittal plane, right side	Processing for preservation or filleting	80-100cm	Hc
Caudal Vert. Group 2	Chopped in sagittal plane, right side (articulates with vertebra below, from context 4031, <1985>)	Processing for preservation or filleting	80-100cm	Hc
Caudal Vert. Group 2	Small knife mark, angled, on right anterior articular surface (articulates with vertebra above, from context 4031, <1985>)	Processing for preservation or filleting	80-100cm	Hc
Caudal Vert. Group 2	Chopped through middle in sagittal plane	Processing for preservation or filleting	80-100cm or >100cm	>2mm
Caudal Vert. Group 2 (x2)	Chopped in sagittal plane, leaving only small wedge of left side	Processing for preservation or filleting	80-100cm or >100cm	>2mm
Caudal Vert. Group 2	Small knife mark on right side, in sagittal plane	Processing for preservation or filleting	80-100cm	>2mm
Caudal Vert. Group 2	Chopped in sagittal plane, leaving only small wedge of bone	Processing for preservation or filleting	80-100cm	>2mm
Caudal Vert. Group 2	Chopped in sagittal plane, removing small wedge of right, anterior vertebra	Processing for preservation or filleting	80-100cm	>2mm
Caudal Vert. Group 2	Small knife mark in sagittal plane, right dorsal spine	Processing for preservation or filleting	>100cm	>2mm
Caudal Vert. Group 2	Chopped through centre in sagittal plane, also knife mark on left articular surface	Processing for preservation or filleting	>100cm	>2mm
Caudal Vert. Group 2 (x6)	Chopped in sagittal plane removing small wedge from right side	Processing for preservation or filleting	>100cm	>2mm
Caudal Vert. Group 2	Chopped in sagittal plane, right side, with small adjacent knife mark	Processing for preservation or filleting	>100cm	>2mm
Caudal Vert. Group 2	Chopped in sagittal plane, leaving only this small wedge of left side	Processing for preservation or filleting	>100cm	>2mm
Cod, early 17th century				
Cleithrum	Small knife mark in frontal plane	Probably processing for preservation, or cooking preparation	80-100cm	Hc
Cleithrum	Chopped in approx. sagittal plane	Processing for preservation	>100cm	Hc
Caudal Vert. Group 2	Chopped in sagittal plane, removing small slice of anterior right articular facet	Processing for preservation or filleting	80-100cm or >100cm	Hc

Caudal Vert. Group 2	Chopped in sagittal plane removing small sliver of right, anterior articular facet	Processing for preservation or filleting	80-100cm	Hc
Caudal Vert. Group 2	Chopped in sagittal plane, right side, removing small slice	Processing for preservation or filleting	80-100cm	Hc
Caudal Vert. Group 2 (x2)	Chopped in sagittal plane, right side, removing small slice	Processing for preservation or filleting	>100cm	Hc

Table 8: Summary of common and Latin names of fish mentioned in the text

Common name	Latin name
Ray Family	Rajidae
Eel	*Anguilla anguilla*
Conger Eel	*Conger conger*
Herring Family	Clupeidae
Atlantic Herring	*Clupea harengus*
Sprat	*Sprattus sprattus*
European anchovy	*Engraulis encrasicolus*
Carp Family	Cyprinidae
Roach	*Rutilus rutilus*
Tench	*Tinca tinca*
Pike	*Esox lucius*
Salmon & Trout Family	Salmonidae
Cod Family	Gadidae
Burbot	*Lota lota*
Cod	*Gadus morhua*
Ling	*Molva molva*
Pollack?	*Pollachius pollachius?*
Whiting	*Merlangius merlangus*
Gurnard Family	Triglidae
Perch	*Perca fluviatilis*
Mackerel Family	Scombridae
Atlantic Mackerel	*Scomber scombrus*
Flatfish Order	Heterosomata (Pleuronectiformes)
Turbot Family	Bothidae
Halibut Family	Pleuronectidae
Halibut	*Hippoglossus hippoglossus*
Plaice	*Pleuronectes platessa*

Figure 1: Example of some of the many large cod family rays and spines found in 16th, late 16th and early 17th century phases (scale is 1cm)

Figure 2: Example of late 16th century butchered cleithra from context 4031, sample 403; modern cleithrum from 82cm total length fish in top left (scale is 1cm)

Figure 3: Example of late 16th century butchered posttemporals from context 4031, sample 403; modern posttemporal from 82cm total length fish in top left (scale is 1cm)

Figure 4: Example of late 16th century butchered vertebrae from context 4031, sample 403 (scale is 1cm)