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Reports from the Centre for Human Palaeoecology, University of York

Report **2008/1**

Technical Report: The fish bone from Hartlepool Town Square, Hartlepool (site code HTQ05)

By

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18 March 2008

THE UNIVERSITY of York

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Summary

This report presents an analysis of the fish bones from domestic deposits at Hartlepool Town Square, Hartlepool. The small assemblage comprised sieved and hand collected bone from phases broadly dated from the 12th century to the early modern period. Results indicated cod family fish, including whiting, haddock and cod were commonly consumed, along with a variety of other species including herring. A shift away from deeper, open water fishing towards shallower, inshore waters occurred at some point in the 13th to 15th centuries. Large cod and ling may have been eaten as prepared, preserved meat, but it is likely most of the fish were consumed fresh. Herrings were found in significant quantities, particularly in the 13th to 15th centuries, corresponding to historical evidence for a small-scale herring fishery. A number of other marine or migratory species were also found in small quantities, and no freshwater species were found.

KEYWORDS: HARTLEPOOL, FISH BONES, ZOOARCHAEOLOGY, MEDIEVAL

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Harland, J. and Parks, R. (2008). Technical Report: The fish bone from Hartlepool Town Square, Hartlepool (site code HTQ05). *Reports from the Centre for Human Palaeoecology, University of York* **2008/1**, 19pp

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The fish bone from Hartlepool Town Square, Hartlepool (site code HTQ05)

Introduction

This report details the analysis of 947 fish bones identified from sieved deposits from Hartlepool Town Square, Hartlepool. A further 372 fish bones were identified from hand collected deposits. Hartlepool is a port city located on the North Sea, only a few miles north of the entrance to the River Tees, a potential source of some freshwater species. Excavation at the Town Square site revealed medieval deposits dating from the earliest settlement of the immediate area. The associated archaeological remains suggest the site was occupied by two medieval properties, complete with assorted domestic evidence including baking or brewing and iron working remains. The initial faunal remains assessment suggested the animal bones were solely the result of domestic consumption, rather than any industrial activities like fish processing (Gidney 2007).

Fish remains were recovered from five broad phases (see Goode 2007), but only phases 2 to 4 contained sufficient quantities of bone to warrant detailed analyses. Phase 1 dates to the 12-14th centuries, phase 2 to 12-15th centuries, and phase 3 to 13-15th centuries. Phase 4 was subdivided into four periods, 4.1 and 4.2 dating to the 13-15th centuries, phase 4.3 to the 14-16th centuries, and phase 4.4 to the 15-17th centuries. The remaining phase 5 encompasses 18th century to modern day material. A variety of domestic context types produced fish bone. Phase 2 includes pit, posthole, post and well fills. Phase 3 includes fills of two limestone lined features. Phase 4.1 also includes a limestone lined feature, phase 4.2 includes fills of ovens, hearths and another limestone lined feature, phase 4.3 includes pit and posthole features and an undefined layer, and phase 4.4 includes more limestone lined feature fills, as well as ovens, postholes, an undefined layer and the fill of a very large medieval pot (context 151). Recovery methods included both sieving and hand collection. Sieved bone comprised 2-4mm and >4mm fractions, both grouped here as >2mm.

Overall preservation of the bone is very good and identification rates were high, making it likely this material can contribute to the understanding of fish consumption at this domestic site. Evidence for fishing grounds exploited and the fish trade can therefore be approached. Chronological resolution is imprecise, but it will be possible to look at broad temporal changes through phases 2 to 4, from approximately the 12-15th centuries until the 15-17th centuries. Additional summary information for phases 1 and 5 is available from the hand collected assemblage, which can extend the chronological range slightly to the early modern period.

Methods

The material was identified to species using the extensive reference collection held by the Department of Archaeology, University of York. Constraints of funding required the assemblage to be recorded in as quick and efficient a manner as possible, while still producing data of sufficient quality. Several strategies were therefore followed to minimise analysis. Firstly, only the larger phases were examined in any detail (phases 2, 3 and 4), because the others contained only small quantities of fish bone. Secondly, the >2mm sieved material from these larger phases was randomly subsampled to produce a dataset of sufficient quantity, incorporating 47 out of 108 samples, or approximately half of all samples. Thirdly, a quick summary recording method was applied to the hand collected assemblage, recording just the minimal information needed to assess species presence, quantities, sizes and butchery patterning.

The sampled dataset was recorded using the York System, an Access database utility designed for recording zooarchaeological assemblages. 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 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. Where comparisons with the other classes of bone (mammal and bird) are available, it can be valuable to record weights of fish. However, the constraints on recording meant that weights were not recorded for Hartlepool Town Square.

Hand collected fish assemblages are naturally biased towards the larger, more readily recognised elements. Without sieving, many of the smaller species, like herrings and eels, are not recovered at all (Jones 1982; Wheeler and Jones 1989). However, hand collected assemblages can provide valuable information about butchery strategies on large cod family fish, particularly of relevance when examining evidence for the medieval trade in preserved cod and related species. For example, the hand collected assemblage at Viking Age and medieval Coppergate, York, proved invaluable for understanding the cod trade (Harland *et al.* in press). Given the time constraints on recording the Hartlepool assemblage, a quick method of recording basic information was devised. Using an Excel spreadsheet, counts of cranial and appendicular elements (QC1 and QC4) and vertebrae (QC2) were recorded by species for each context. QC1 elements were divided into broad and easily recognisable size categories. No record was kept of individual elements unless butchered or pathological, and no measurements were taken.

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

The fish bone was generally well preserved (Table 1), with high quantities of complete or near complete elements found. Bone surface textures were generally excellent or good. The later phases were slightly better preserved than the earlier ones, but this was unlikely to have had a detrimental affect on bone survival.

Within the hand collected assemblage, one example of crushing was observed, five fragments were charred, and a further five crushed elements were found in the sieved subset; these were distributed through all phases. The very low rate of burning is unusual, perhaps suggesting that burning of household rubbish did not occur on site. One gadid ceratohyal from phase 4.4 had been chewed by a cat (indicated by puncture marks) but otherwise the assemblage was not subject to many modifications.

Results

Species

A total of 3377 bones were examined from the sieved fraction, of which 947 were identified to element and species (QC1, QC2 or QC4) from the sieved fraction. A further 372 diagnostic elements were identified from the hand collected material, out of a total of 815 hand collected bones. The majority of species identified belonged to the cod family (see Table 6 for a summary of common and Latin names),

particularly whiting, haddock and, in smaller quantities, cod. Herrings were also found in considerable numbers, and the pleuronectid flat fishes made a small contribution to the diet.

Table 2 presents basic number of identified species present (NISP) data by species, for both sieved and hand collected portions. Looking at all sieved bone examined, the species recovered comprise, in rank order: whiting, herring, haddock, cod family, cod, halibut family, ray family, saithe, gurnard family, ling, flounder, herring family, plaice, dogfish families, Atlantic mackerel, thornback ray, eel, cod/saithe/pollack, grey gurnard, turbot family, halibut and flounder/plaice. In addition, a single identified spurdog was noted but was QC0.

The fish species found indicate a reliance on marine fishing, which is not surprising given the location of Hartlepool on the North Sea. Some of the herring and flatfish species may have been caught in estuarine conditions, and one eel was found (a migratory species most often caught in fresh water), but no freshwater fish were recovered – despite the proximity of the River Tees – suggesting only marine fish were consumed here. The paucity of eels would support this. All of the species recovered here could easily have been caught in the North Sea. Contemporary sites from England share this reliance on marine fishing, particularly cod, cod family and herring (Barrett *et al.* 2004a; Barrett *et al.* 2004b).

Changes through time can be examined for the major species between phases 2 and 4. Whiting became increasingly and steadily more common through time, at less than 10% in phase 2 to almost 60% by phase 4.4. Haddock remained approximately the same, at 15-20% through all phases, while cod decreased from about 10% in phases 2 and 3 to only 3% by phase 4.4. Ling and saithe, two other members of the cod family, similarly decreased through time. Herrings increased from phase 2 (35%) to phase 3 (50%), then decreased to only 6% by phase 4.4. Other fish, like the flatfishes, gurnards and rays, showed little change through time.

The hand collected assemblage was naturally biased towards the larger, more readily identifiable fish, including many of the large cod family species. However, a pit fill from phase 3, context 738, contained surprising quantities of smaller elements and species, accounting for all of the hand collected herring and almost all of the smaller whiting; this was very unusual for hand collection but was typical of the sieved deposits from this context. Table 2 presents the basic NISP data, showing that the species recovered, in rank order, were: cod, ling, haddock, whiting, saithe, herring, halibut family, turbot family, thornback ray and conger eel. Cod family fish account for 95% of all hand collected fish, with cod representing almost half of all fish recovered using this method. Cod became slightly more common through time, as did saithe and haddock, but ling was found in large quantities in phase 1, then declined through the later phases.

Fish sizes

Fish sizes were recorded for sieved and hand collected QC1 elements, as summarised in Table 3. Hand collection produced more bones that could be sized, but they are naturally biased towards larger fish; most of these cod family fish recovered are at least 80cm estimated total length. Some changes through time can be identified in the hand collected material. Cod increased in size through time, from mostly 80-100cm in phases 2 and 3 to mostly >100cm total length by phases 4.1, 4.2, 4.3 and 4.4. In contrast, phases 1 and 5 had equal low levels of each size of cod. The marked change between phase 3 and 4.1 suggests a major shift in preference towards the larger fish. Haddock, ling and saithe show few changes through time. One unusually well recovered context from phase 3 contained equal quantities of 15-30cm and 30-50cm total length whiting.

Smaller quantities of sieved bones could be sized. The sieved cod became larger between phases 2 and 3 (shifting from 50-80cm total length to 80-100cm total length). In phase 4.3 a large range of sizes was recovered, with a slight emphasis on 15-30cm total length, and again a range of sizes was found in phase

4.4, with a slight emphasis on 50-100cm total lengths. Although difficult to reconcile the two recovery methods, the trends through the early phases are the same, namely an increase in cod size from phase 1 to phase 3, and this likely continued into the later phases, with small quantities of smaller cod found in phases 4.3 and 4.4 in addition to the larger ones. This likely suggests exploitation of two separate fishing areas, one producing large cod from open water, off shore areas, and one producing smaller cod from inshore waters in the later period only, particularly in phase 4.3. The haddock from the sieved material show a slight decrease in size through time, from predominately 30-80cm total length in phases 2 and 3 to predominately 15-50cm in phases 4.3 and 4.4. Phase 4.3 contains unusually high proportions of 15-30cm haddock, mirroring the pattern observed for the cod and suggesting more intensive exploitation of inshore waters. Whiting quantities increase in the later phases, while at the same time sizes decrease; in phase 2 there are equal quantities of 15-30cm and 30-50cm total length fish, but by phase 4.3 and 4.4 there were twice as many 15-30cm as 30-50cm total length whiting; this again suggests a change of fishing grounds through time, moving more towards increased exploitation of inshore waters in the later phases.

Element distribution

The proportions of fish elements present in an assemblage can be used to examine evidence of fish processing. Large cod and cod family fish can be butchered when fresh to remove most of the head and anterior vertebrae, and can then be air dried or salted to preserve the meat. This can then be shipped to a consumption site, where their remains, in the form of vertebrae and the cleithra – two large, paired elements at the back of the head – would be found (see Perdikaris 1996; Barrett 1997; Harland 2006 and references therein for archaeological and historical evidence for this well established trade within the North Sea and North Atlantic regions). Differences in proportions and sizes of cranial elements, cleithra and vertebrae can then be analysed to determine if a site contains entire fish, consumed whole, if any evidence of processing was found, or if consumption of prepared fish likely took place. This can be complemented by butchery evidence, discussed below.

The hand collected cod and larger cod family fish, like ling, are sizes that could include prepared, traded fish, as are a few of the sieved cod and cod family fish. The small sample sizes, as well as the recording limitations, meant it was inefficient to record quantities of individual elements for the hand collected assemblage. However, during recording it was noted that one context (738 from phase 3) contained classic element patterning of appendicular elements and vertebrae suggesting importation of ready-prepared fish. This context has already been discussed above, because although hand collected, it contained large quantities of small species and elements and is thus unusual. All other contexts and phases contained a variety of elements, suggesting both freshly caught fish and imported prepared meat may have been consumed, with a definite emphasis on whole fish likely being consumed fresh.

Butchery and pathology

Twenty-two butchered fish bones were found in the hand collected assemblage, with a further four recorded from the sieved material (Table 5). From the hand collected material, two were ling, one was conger eel, one was turbot family and the rest were cod, predominantly from large fish; sieved material included three articulating small pleuronectidae vertebrae and a small whiting cleithrum. Some were consistent with imported, preserved large cod family fish, including the butchery marks to the cleithra and vertebrae in phases 2, 3 and 4.4, but most were of unknown function possibly associated with fresh fish consumption. The earliest evidence for importing cod comes from phase 3, as the one example from phase 2 was ling.

Pathological indicators are rare in fish assemblages, but three examples were found, all cod cleithra from phase 3. One was from a fish of >100cm total length, which contained a hole in the ventral tip, and another from a fish of c.65-80cm total length contained a pathological growth on the lateral edge. Another example is very unusual and is illustrated below in Figure 1; this cleithra from a fish of >100cm

contained a large lump of dense, amorphous bone on the lateral edge of the cleithra, which was chopped through during butchery.

Summary and conclusions

The small, well preserved fish bone assemblage from Hartlepool Town Square represents domestic fish consumption from the 12th century to the early modern period. These fish were likely caught from relatively local waters in the North Sea, and there was no evidence to indicate consumption of freshwater fish. A variety of species were found, most of which were from the cod family, including whiting, haddock and cod. Cod increased in size between phase 3 and 4.1, possibly indicating a shift in fishing grounds some time in the 13th to 15th centuries. Earlier phases tended to contain cod and ling, while the later phases from the 14th to 17th centuries contained large quantities of whiting. It is likely that deeper, more open waters were exploited by fishermen in the earlier phases, along with some inshore waters, but by the later centuries, shallower waters closer to shore were exploited more than any other fishing grounds. Fishing for the larger species, including cod, was probably by long-lining, while smaller species may have been caught by hook and line (including whiting) or by netting (herrings).

Evidence for importation of prepared cod and cod family species, like ling, is scarce, but some fish may have been imported in phase 2, increasing into phases 3 and 4 before declining by phase 5; most fish consumed at Hartlepool were likely consumed fresh. This interpretation is based on element patterning, butchery marks and fish sizes, but the small quantities of bone involved make it difficult to draw decisive conclusions regarding the consumption or chronology of prepared fish. Nevertheless, historical evidence states that some salted cod was present in medieval Hartlepool (Daniels 1991).

Herrings were very common in the earlier phases, particularly the 13-15th century phase 3, when they represented half of all identified bones, but they decreased to trace levels by later centuries. This corresponds to historical evidence for a small early 14th century herring fishery at Hartlepool, including the 'great herring house' built at the shore c.1325 (Daniels 1991), when Dutch fishermen were known to land herring catches (Childs 2000). Given the proximity to the shore, the herrings found at the Town Square site could have been eaten fresh or lightly cured. The later decline of the herring fishery at Hartlepool mirrors that observed throughout the English North Sea ports (Woolgar 2000).

A very brief bone report from the Hartlepool Town Wall Excavations in 1978 mentioned the presence of very large cod and haddock bones, several of which were butchered, from 13th-15th century hand collected deposits (Jones and Rackham 1979). This is consistent with the recent finds discussed here, and provides further evidence that prepared cod and cod family fish were likely consumed in Hartlepool. Earlier material recovered from the Anglo-Saxon monastery in Hartlepool suggested exploitation of a wide range of local species, without the later reliance on cod family fish (Locker 1988), while medieval domestic deposits from the same site indicated exploitation of marine resources, including deep, open water producing large cod family species (Locker 1990). Element proportion evidence from the early medieval Southgate site, Hartlepool, suggest cod and cod family fish may have been processed into preserved products at the site, with consumption occurring elsewhere (Locker 2000) – possibly even at the Town Square site.

Acknowledgements

The identification and analysis of the Hartlepool Town Square fish was funded by Hartlepool Borough Council as part of the Town Square development.

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Tables and figure

Table 1: Taphonomy data

Percent completeness of elements

QC1 >2mm sieving											
Phase	1-20%		20-40%		40-60%		60-80%		80-100%		Total
2			8	13%	19	30%	14	22%	23	36%	64
3			3	18%	3	18%	2	12%	9	53%	17
4.1							2		2		4
4.2			1				1		2		4
4.3			5	8%	17	28%	17	28%	22	36%	61
4.4	6	2%	31	12%	37	15%	47	19%	133	52%	254
Total	6	1%	48	12%	76	19%	83	21%	191	47%	404

Surface texture

QC1, >2mm sieving									
Phase	Excellent		Good		Fair		Poor		Total
2	14	22%	45	70%	5	8%			64
3	1	6%	7	41%	9	53%			17
4.1	2		2						4
4.2			3		1				4
4.3	17	27%	34	55%	11	18%			62
4.4	91	36%	144	56%	19	7%	1	0%	255
Total	125	31%	235	58%	45	11%	1	0%	406

Quantities of diagnostic elements per phase

Phase	QC0		QC1		QC2		QC4		Total
2	814	75%	64	6%	189	18%	13	1%	1080
3	131	67%	17	9%	43	22%	5	3%	196
4.1	9	50%	4	22%	5	28%			18
4.2	70	73%	4	4%	17	18%	5	5%	96
4.3	566	76%	60	8%	110	15%	4	1%	740
4.4	840	67%	256	21%	141	11%	10	1%	1247
Total	2430	72%	405	12%	505	15%	37	1%	3377

Table 2: Number of identified specimens (NISP) by species (p=present but non-diagnostic)

NISP by phase for >2mm sieving, based on quantification of diagnostic elements (QC1, QC2, QC4)													
Family	Common name	Phase 2		3		4.1	4.2	4.3		4.4		Total	
Scyliorhinidae/ Squalidae	Dogfish Families							2	1.1%			2	0.2%
Squalidae	Spurdog			p									
Rajidae	Ray Family	7	2.6%					1	0.0%	11	2.7%	19	2.0%
	Thornback Ray	1	0.0%									1	0.0%
Anguillidae	Eel						1					1	0.0%
Clupeidae	Herring Family	4	1.5%									4	0.4%
	Atlantic Herring	95	35.7%	33	50.8%	5	17	44	25.3%	23	5.7%	217	22.9%
Gadidae	Cod Family	14	5.3%	3	4.6%		3	15	8.6%	19	4.7%	54	5.7%
	Cod/ Saithe/ Pollack	1	0.0%									1	0.0%
	Cod	25	9.4%	7	10.8%		1	10	5.7%	10	2.5%	53	5.6%
	Haddock	49	18.4%	10	15.4%		2	34	19.5%	82	20.1%	177	18.7%
	Whiting	22	8.3%	11	16.9%	3	1	53	30.5%	238	58.5%	328	34.6%
	Saithe	15	5.6%				1	3	1.7%			19	2.0%
	Ling	8	3.0%			1						9	1.0%
Triglidae	Gurnard Family	4	1.5%					4	2.3%	5	1.2%	13	1.4%
	Grey Gurnard	1										1	0.0%
Scombridae	Atlantic Mackerel	1								1		2	0.2%
Bothidae (Scophthalmidae)	Turbot Family	1										1	0.0%
Pleuronectidae	Halibut Family	14	5.3%	1				7	4.0%	13	3.2%	35	3.7%
	Halibut	1										1	0.0%
	Flounder/ Plaice									1	0.0%	1	0.0%
	Flounder	2	0.8%					1	0.0%	2	0.5%	5	0.5%
	Plaice	1								2	0.5%	3	0.3%
Total identified (QC1, QC2, QC4)		266	100%	65	100%	9	26	174	100%	407	100%	947	100%
Unidentified (QC0)		814		131		9	70	566		840		2430	
Total		1080		196		18	96	740		1247		3377	

Hand collected NISP by phase, based on summary quantification of diagnostic elements (QC1, QC2, QC4)													
Family	Species	Ph. 1	2	3		4.1	4.2	4.3	4.4		5	Total	
Rajidae	Thornback ray								1	1%		1	0%
Congridae	Conger eel								1	1%		1	0%
Clupeidae	Herring			11	8%							11	3%
Gadidae	Cod	11	9	65	45%	35	6	19	45	55%	10	180	48%
	Haddock		4	14	10%	6	2	2	16	20%	7	51	14%
	Whiting			34	23%				2	2%	3	39	11%
	Saithe		3	5	3%	3		1	7	9%		17	5%
	Ling	20	4	14	10%	9		4	9	11%	5	65	18%
Bothidae			1					1				2	1%
Pleuronectidae				3	2%	1			1	1%		5	1%
Total identified		31	21	146	100%	54	8	27	82	100%	25	372	100%
Unidentified (QC0)		46	9	210		27	10	31	102		8	443	
Total		77	30	356		81	18	58	184		33	815	

Table 3: Fish size summary

>2mm sieved fish estimated total lengths								
Common name	Total length	Phase 2	3	4.1	4.2	4.3	4.4	Total
Eel	15-30cm				1			1
Atlantic Herring	15-30cm	7	5	2	3	14	9	40
	30-50cm					1		1
Cod Family	15-30cm	3			2	1	2	8
	30-50cm						1	1
Cod	<15cm					1		1
	15-30cm					3	1	4
	30-50cm	1	1			1	1	4
	50-80cm	5	1			1	2	9
	80-100cm	1	5				2	8
	>100cm	1				1		2
Haddock	15-30cm	2	1			10	11	24
	30-50cm	7	2			3	25	37
	50-80cm	8	3			1	5	17
Whiting	15-30cm	5		2		10	121	138
	30-50cm	4	1			5	57	67
	50-80cm						2	2
Saithe	15-30cm				1	2		3
	30-50cm	1						1
	50-80cm	2						2
	80-100cm	1						1
	>100cm	4						4
Ling	>100cm	3						3
Gurnard Family	50-80cm	1						1
Grey Gurnard	30-50cm	1						1
Halibut Family	15-30cm	2				1	5	8
	30-50cm					1		1
Halibut	50-80cm	1						1
Flounder/ Plaice	15-30cm						1	1
Flounder	15-30cm	2					2	4
	30-50cm					1		1
Plaice	15-30cm						1	1
	30-50cm	1					1	2

Hand collected fish estimated total lengths									
Taxa	Total length	Ph. 1	2	3	4.1	4.2	4.3	4.4	5
Cod	50-80cm			7		1		2	
	80-100cm	4	3	20	4	1	6	11	2
	>100cm	5	1	11	26	3	11	15	2
Ling	80-100cm	2		1	1			1	1
	>100cm	8	3	8	1		4	6	3
Whiting	15-30cm			10					1
	30-50cm			13				1	2
Haddock	30-50cm		1	4	3			6	2
	50-80cm		3	4	3	2	2	6	3
	80-100cm			1				2	1
Saithe	80-100cm		2	1	2			3	
	>100cm		1	3	1			4	

Table 4: Element quantification

Common name	Element Output	Phase 2	3	4.1	4.2	4.3	4.4	Total
Dogfish Families	Mineralized Vertebral Centrum					2		2
Ray Family	Dermal Denticle	7				1	10	18
	Mineralized Vertebral Centrum						1	1
Thornback Ray	Dermal Denticle	1						1
Eel	Vomer				1			1
Herring Family	Articular	1						1
	Caudal Vertebra	3						3
Atlantic Herring	Articular					1	3	4
	Ceratohyal	1			1	3	3	8
	Cleithrum						1	1
	Dentary		1					1
	Hyomandibular	1				2		3
	Maxilla	2		1		3		6
	Otic Bulla	5	4		4	3		16
	Posttemporal		1			3		4
	Preopercular			1			2	3
	Quadrate	1	1			4		6
	Abdominal Vertebra	27	15		1	10	8	61
	Caudal Vertebra	58	11	3	10	15	6	103
	Ultimate Vertebra				1			1
Cod Family	Ceratohyal						2	2
	Dentary	1					1	2
	Infrapharyngeal	1			1		1	3
	Maxilla	1				1	2	4
	Opercular	1			1			2
	Otolith		1		1			2
	Palatine	1					2	3
	Parasphenoid						3	3
	Posttemporal					1	1	2
	Premaxilla	1						1
	Quadrate					1	1	2
	Vertebra						1	1
	Vomer	1						1
	First Vertebra					1		1
	Abdominal Vertebra		1			7	3	11
	Caudal Vertebra	4	1			4		9
	Caudal Vertebra Group 1	1						1
	Caudal Vertebra Group 2	1					2	3
	Ultimate Vertebra	1						1
Cod/ Saithe/ Pollack	Abdominal Vertebra Group 1	1						1
Cod	Articular		1					1
	Basioccipital	1						1
	Ceratohyal		1					1
	Cleithrum	1						1
	Dentary		1			2	1	4
	Hyomandibular	1				2	1	4
	Infrapharyngeal	1	1				1	3
	Opercular	1					1	2
	Palatine	1						1
	Parasphenoid					1		1
	Premaxilla						2	2
	Quadrate	2	2					4
	Supracleithrum		1			1		2

Common name	Element Output	Phase 2	3	4.1	4.2	4.3	4.4	Total
	Vomer					1		1
	First Vertebra	1						1
	Abdominal Vertebra Group 1	5						5
	Abdominal Vertebra Group 2	2					1	3
	Abdominal Vertebra Group 3	4				2	2	8
	Caudal Vertebra				1			1
	Caudal Vertebra Group 1	3					1	4
	Caudal Vertebra Group 2	2				1		3
Haddock	Articular					2	4	6
	Ceratohyal	1				2	3	6
	Cleithrum		2				4	6
	Dentary	1	1			1		3
	Hyomandibular	1				1	1	3
	Infrapharyngeal						1	1
	Maxilla	1	1			1	3	6
	Opercular	2				2	3	7
	Palatine	2					1	3
	Parasphenoid						1	1
	Posttemporal	1						1
	Premaxilla	2	1			2		5
	Preopercular	1					3	4
	Quadrate		1			1	7	9
	Scapula					1	2	3
	Supracleithrum	1					7	8
	Vomer	1				1	1	3
	First Vertebra				1		2	3
	Abdominal Vertebra Group 1	3				1	2	6
	Abdominal Vertebra Group 2	7				3	3	13
	Abdominal Vertebra Group 3	6	1			4	12	23
	Caudal Vertebra					2		2
	Caudal Vertebra Group 1	11	2			9	15	37
	Caudal Vertebra Group 2	8	1		1	1	7	18
Whiting	Articular	3				1	16	20
	Basioccipital	2					5	7
	Ceratohyal						15	15
	Cleithrum					1	5	6
	Dentary					3	16	19
	Hyomandibular			1			19	20
	Infrapharyngeal		1			2	3	6
	Maxilla	1				1	12	14
	Opercular						4	4
	Palatine	1				1	10	12
	Parasphenoid	1						1
	Posttemporal	1				1	8	10
	Premaxilla					2	27	29
	Preopercular						12	12
	Quadrate			1		1	17	19
	Scapula						3	3
	Supracleithrum					1	2	3
	Vomer	1				1	6	8
	First Vertebra	2					1	3
	Abdominal Vertebra Group 1						2	2
	Abdominal Vertebra Group 2				1	3	3	7
	Abdominal Vertebra Group 3		2			12	8	22
	Caudal Vertebra	2					1	3

Common name	Element Output	Phase 2	3	4.1	4.2	4.3	4.4	Total
	Caudal Vertebra Group 1	6	7	1		15	31	60
	Caudal Vertebra Group 2	2	1			8	12	23
Saithe	Ceratohyal	1						1
	Dentary					1		1
	Hyomandibular	1						1
	Infrapharyngeal	1						1
	Maxilla					1		1
	Parasphenoid	1						1
	Premaxilla	2						2
	Quadrate	1						1
	Vomer	1						1
	Abdominal Vertebra Group 1	1						1
	Abdominal Vertebra Group 2				1			1
	Caudal Vertebra Group 1	4				1		5
	Caudal Vertebra Group 2	2						2
Ling	Ceratohyal	1						1
	Parasphenoid	1						1
	Posttemporal	1						1
	Abdominal Vertebra Group 2	1						1
	Abdominal Vertebra Group 3			1				1
	Caudal Vertebra Group 1	4						4
Gurnard Family	Ceratohyal	1						1
	Abdominal Vertebra						1	1
	Caudal Vertebra	3				4	4	11
Grey Gurnard	Opercular	1						1
Atlantic Mackerel	Caudal Vertebra	1					1	2
Turbot Family	Caudal Vertebra	1						1
Halibut Family	Articular					1	1	2
	Basioccipital						1	1
	Dentary	1						1
	Hyomandibular	1						1
	Quadrate					1		1
	Abdominal Vertebra	2					2	4
	Caudal Vertebra	10	1			4	9	24
	Caudal Vertebra Group 2					1		1
Halibut	Premaxilla	1						1
Flounder/ Plaice	Hyomandibular						1	1
Flounder	Articular	1					1	2
	Dentary						1	1
	Hyomandibular					1		1
	Maxilla	1						1
Plaice	Articular						1	1
	Infrapharyngeal						1	1
	Maxilla	1						1

Table 5: Butchery summary

Species	Ph.	Element	Description	Interpretation	Size
Sieved >2mm					
Pleuro-nectidae	4.4	Caudal Vertebrae	3 vertebrae in articulation, chopped in sagittal plane just off midline	Filleting	15-30cm
Whiting	4.4	Cleithrum	Small knife mark in frontal plane, lateral dorsal position	Decapitation	30-50cm
Hand collection					
Cod	1	Abdominal Vertebra Group 3	Small knife mark on anterior right side, on the edge of the articular facet, in the frontal plane sloping slightly upwards	? Possibly processing for preservation	80-100cm
Cod	3	Cleithrum	Small chop on lateral side, in middle, in sagittal plane, oblique	Processing for preservation	c.65-80cm
Cod	3	Cleithrum	Chopped through, frontal plane, in middle; with pathology as illustrated in Fig.1	Processing for preservation	>100cm
Cod	3	Dentary	Chopped just adjacent to central articulation, diagonally	?	80-100cm
Cod	3	Premaxillae	2 chopped through, sagittal plane, just adjacent to medial articulation	?	>100cm
Cod	3	First Vertebra	Chopped on left side in sagittal plane	? Processing for preservation	>100cm
Cod	3	Caudal Vertebra Group 1	Small knife marks on ventral surface, in transverse plane, across exact underside of vertebra	Processing for preservation	80-100cm
Cod	4.1	Opercular	Chopped through articulation	?	>100cm
Cod	4.1	Vomer	Chopped in frontal plane, removing left side tooth row	?	80-100cm
Cod	4.1	Premaxilla	Chopped approx. in sagittal plane, on inner surface of tooth row, just adjacent to medial articulation	?	>100
Cod	4.1	Parasphenoid	Series of chops in transverse plane, also oblique skimming surface	Decapitation?	>100
Cod	4.3	Basioccipital	Chopped diagonally through articulation with parasphenoid	Decapitation?	>100cm
Cod	4.3	Dentary	Chopped in frontal plane removing lateral part of tooth row	?	>100cm
Cod	4.3	Dentary	Chopped in sagittal plane, removing small part of the medial articular surface	?	>100cm
Cod	4.3	Premaxilla	Chopped in sagittal plane through middle of medial articulation	?	80-100cm
Cod	4.4	Cleithrum	Small knife marks in frontal plane, on medial side of dorsal tip, and chop obliquely removed ventrally to medial tip	Processing for preservation	>100cm
Cod	4.4	Dentary	Chopped in sagittal plane, removing small part of the medial articular surface, with knife marks in sagittal plane on tooth row from dorsal to ventral	?	>100cm
Cod	4.4	Abdominal Vertebra Group 1	Chopped twice in transverse plane	? Processing for immediate consumption or preservation	>100cm
Ling	2	Cleithrum	Knife and chop marks on lateral side, in middle, in approximately	Processing for preservation	>100cm

Species	Ph.	Element	Description	Interpretation	Size
			frontal plane		
Ling	4.1	Abdominal Vertebra Group 3	Butchery in transverse plane, but with very blunt, wide instrument	?	>100cm
Bothidae	2	Anterior Caudal Vertebra	Chopped through in transverse plane	?	50-60cm
Conger eel	4.4	Cleithra	2 knife marks in middle	?	>100cm

Table 6: Summary of common and Latin names of fish mentioned in the text

Common name	Latin name
Dogfish Families	Scyliorhinidae/Squalidae
Smallspotted Catshark/ Lesser Spotted Dogfish	*Scyliorhinus canicula*
Ray Family	Rajidae
Spurdog	*Squalus acanthias*
Thornback Ray	*Raja clavata*
Eel	*Anguilla anguilla*
Herring Family	Clupeidae
Atlantic Herring	*Clupea harengus*
Cod Family	Gadidae
Cod/ Saithe/ Pollack	*Gadus/Pollachius*
Cod	*Gadus morhua*
Haddock	*Melanogrammus aeglefinus*
Whiting	*Merlangius merlangus*
Saithe	*Pollachius virens*
Ling	*Molva molva*
Gurnard Family	Triglidae
Grey Gurnard	*Eutrigla gurnardus*
Atlantic Mackerel	*Scomber scombrus*
Turbot Family	Bothidae
Halibut Family	Pleuronectidae
Halibut	*Hippoglossus hippoglossus*
Flounder/ Plaice	*Pleuronectes flesus/P. platessa*
Flounder	*Pleuronectes flesus*
Plaice	*Pleuronectes platessa*

Figure 1: Pathological, butchered cod cleithrum from >100cm total length fish, phase 3, shown with modern example