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WHITBY ABBEY HEADLAND, NORTH YORKSHIRE
OSTEOLOGICAL ANALYSIS OF HUMAN REMAINS FROM THE WHITBY ABBEY HEADLAND PROJECT: SOUTHERN ANGLIAN ENCLOSURE 1999-2000

ENVIRONMENTAL STUDIES REPORT

Stefanie Vincent and Simon Mays

ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

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WHITBY ABBEY HEADLAND

Osteological analysis of Human Remains from Whitby, Whitby Abbey Headland Project: Southern Anglian Enclosure 1999-2000.

S Vincent and S Mays

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SUMMARY
225 inhumations and 1 cremation were excavated from the Southern Anglian Enclosure as part of the Whitby Abbey Headland Project in 1999 and 2000. All inhumations were very fragmentary and analysis concentrated on the dentition, producing age and non-metric data. A sampling regime was in place during excavation and an analysis of the success of this is presented.

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INTRODUCTION.

The cemetery under investigation is 7th-9th century AD Anglian. Excavations took place over two field seasons in 1999 and 2000, following previous test trenching which had revealed that the preservation of the human remains on the site was extremely poor. To accommodate this, a sampling program was designed which would both aid in the recovery of skeletal material and allow investigation into the efficiency of different sampling approaches.

In total 225 inhumations and 1cremation were recovered from the site and due to the poor preservation of skeletal material, analysis focussed mainly on the dentition. The majority of the cemetery was laid out in rows and the grave orientation, lack of grave goods and presence of a putative church at the site suggests a Christian burial ground. The cemetery was incompletely excavated, although the southern extent was established.

The cemetery was dated to the Anglian period on the basis of finds recovered during the excavation and historical documentation referring to the area (Sherley-Price *et al.*, 1990). It was hoped that carbon dating of the human remains would provide a more specific period of use for the cemetery, however the collagen content of the human bone proved inadequate for analysis.

DEMOGRAPHY.

Adult sex was determined by skull and pelvis morphology (White and Folkens, 2005). Older juveniles with fused acetabula were also sexed this way. No attempt was made to sex younger individuals.

Aging of juveniles was undertaken using dental formation (Gustafson and Koch 1974, reproduced in Hillson, 1996 pp 135; Mays, 1998). Adult age was determined using molar wear (Brothwell, 1981). The degradation of the bone recovered meant that no supplementary osteological techniques could be applied.

There were 22 individuals for whom neither age nor sex could be determined, due to the small amount of bone recovered from the burials. These individuals have not been included in the demographic breakdown below:

Table 1: Adult Demography at Whitby

		Age Range					
		Adult	18 - 29	30 - 39	40 - 49	50+	Total
Sex	Female	0	0	0	0	0	0
	Probable Female	0	2	1	1	1	5
	Male	0	1	3	1	3	8
	Probable male	1	0	1	1	0	3
	Unsexed Adult	53	44	50	7	5	159
	Total	54	47	55	10	9	175

Aging by dental attrition uses ante-mortem tooth loss as a criteria for assigning an age of 50+ to an individual (Mays, 1998; 62). As the mandible and maxilla (either whole or in part) rarely survived in the Whitby material the 50+ age group will be under represented.

Table 2: Juvenile Demography at Whitby

		Age Range			
		0 - 6	7 - 11	12 - 17	Total
Sex	Female	0	0	0	0
	Probable Female	0	0	0	0
	Juvenile	6	18	4	28
	Male	0	0	0	0
	Probable male	0	0	0	0
	Total	6	18	4	28

Juvenile age ranged from 1-16 years.

The age at death for Whitby juveniles shows a peak in the 7-11 group, unlike that seen in other contemporary northern sites.

Table 3: comparing the distribution of juvenile ages

Site	Date	0-6	7-11	12-17	Total
Norton	6th-7th century	6	17	14	37
West Heslerton	5th-7th century	17	6	8	31
Wharram Percy	10th-19th century	232	60	35	327
Whitby	7th-9th century	6	18	4	28

As seen in the table above the proportion of juveniles in the 7-11 and 12-17 catagories at Whitby is similar to the seen at Wharram Percy, a primarily late medieval Christian cemetery (Mays, 2007). However the Wharram Percy population shows a large peak in the 0-6 age group which is not seen at Whitby. Juvenile bone is more susceptible to degradation in adverse soil conditions (Mays, 1998; 21) and this may account for the difference in the numbers of juveniles in this category; whilst the preservation of bone at Whitby was poor, preservation at Wharram Percy was very good (Mays, 2007).

Although the numbers of unsexed adults makes analysis of sex distribution problematic the presence of both sexes and juveniles identifies the cemetery as one serving a lay population.

DENTAL NON-METRICS

Dental non-metric traits are a series of morphological differences in tooth form. The exact cause of non-metric traits is unknown; however a combination of environmental and genetic factors seems to be the most likely influence.

Methods

The selection of traits was guided by previous studies on British and European material, (Berry, 1976; 1978) and on the basis of how robust a specific trait was to the effects of attrition. As the majority of the teeth from the Whitby material were separated from their sockets, root traits were also included in the scoring. The chosen traits were scored as described in the Arizona State University Dental Anthropology System [ASUDAS] (Turner *et al.*, 1991), using the companion casts supplied. The exception to this was the recording of the tuberculum dentale of the upper anterior dentition. The ASUDAS scoring system describes the grooving and nodule characteristics of the tuberculum dentale as mutually exclusive expressions of the same trait, however several teeth in the Whitby dentition showed both grooving and nodule development. To overcome this, the grooved cingulum and cingular nodule were scored as two separate traits using presence/absence criteria. The ASUDAS criteria (Turner *et al.*, 1991) were still applied to ascertain a positive expression of the traits.

Research has shown that scoring dental non-metric traits on a graded scale results in more positive expressions of the trait being recognised. However the results must be dichotomised to allow further analysis. The dichotomies of the traits are shown below, cut points have been established with reference to previous studies (Coppa *et al.*, 2007; Irish, 1997; 2005; 2006; Sofaer *et al.*, 1986):

Table 4: showing the dichotomy of non-metric traits

Trait	Absence	Presence
Grooved Cingulum	Absence	Presence
Cingular Nodule	Absence	Presence
Carabelli's Trait	Grade 0	ASUDAS Grades 1-7
Fissure pattern	+/X	Y
Protostylid	Grade 0	ASUDAS Grades 1-6
Canine Root no.	1 root	2+ roots
Tomes Root	Grade 0	ASUDAS Grade 1
Lower molar root no.	2 roots	Root number other than 2

The individual count method as described by Scott (1980) was used to report trait presence. This method assigns a positive or negative expression to an antimere pair, based on the highest expression on the trait. Take for example the Carabelli's trait on the maxillary M1. If the left tooth scored 0 and the right scored 4 the overall score for the Carabelli's trait would be 4 (or positive when dichotimised). The method is based upon the assumption that each trait has a genetic origin and maximises sample size as individuals with a missing antimere can be included in the results (see Scott, 1980 for more information).

Once the dentition of several individuals had been scored ten dentitions were re-scored by the original examiner and a second observer to establish the level of intra and inter-observer error. Based on these results all individuals were re-graded and their scores based on a concordance of both observers. This criterion was followed for the remaining burials.

Juvenile dentition was scored for Carabelli's trait and the protostylid; the other traits are not considered appropriate for application to juveniles (Hillson, 1996; Turner *et al.*, 1991). Other non-metric traits such as enamel extensions and pearls, along with retained deciduous dentition and reduced teeth were noted as observed. Where preservation of the mandible and/or maxilla was sufficient for observation, congenitally absent teeth were noted.

Results

The grooved cingulum and cingular nodule are scored on the anterior dentition of the maxilla. The results are shown below;

Table 5: frequency of the grooved cingulum and cingular nodule.

	Maxillary Canine		Maxillary 2nd Incisor		Maxillary 1st Incisor	
	Grooved Cingulum	Cingular Nodule	Grooved Cingulum	Cingular Nodule	Grooved Cingulum	Cingular Nodule
Absent	35	38	5	23	16	35
Present	11	8	21	3	19	0
% Present	23.9	17.4	80.8	11.5	54.3	0
Total	46		26		35	

As non-metric dental traits are not routinely recorded in British populations where bone preservation is good, there is limited comparable material for the Whitby site. Trentholme Drive is a Romano-British site in York which was reported on in 1968 (Cooke and Rowbotham 1968). The dental section of this report shows that the presence of the cingular nodule recorded at Trentholme drive was much lower than that seen at Whitby with the trait found in 0% of canines, 0.5% of second incisors and 0.46% of first incisors.

Carabelli's cusp is found on the lingual aspect of the mesiolingual cusp (cusp 1) of the maxillary molars (Turner *et al.*, 1991). The results are shown below;

Table 6: frequency of the Carabelli's Trait.

	Maxillary 3rd Molar		Maxillary 2nd Molar		Maxillary 1st Molar	
	Whitby	Trentholme Drive	Whitby	Trentholme Drive	Whitby	Trentholme Drive
Absent	29	170	46	219	24	192
Present	8	5	3	2	11	30
% Present	21.6	2.9	6.1	0.9	31.4	15.6
Total	37	175	49	221	35	222

As is seen in the results above the Whitby population exhibited a much higher presence of Carabelli's trait than was found at Trentholme Drive. It should be noted that while the Trentholme Drive material was examined using a graded scale of expression the scale used comprised only three grades (Cooke and Rowbotham, 1968) and some of the disparity may be an artefact of differing methodologies.

Fissure pattern, presence of protostylid and root number are all scored on the mandibular molars. The results are shown below;

Table 7: frequency of mandibular molar traits

Fissure Pattern	Mandibular 3rd Molar	Mandibular 2nd Molar	Mandibular 1st Molar
X/+	18	29	3
Y	14	20	21
Total	32	49	24
Protostylid			
Absent	32	36	27
Present	6	18	18
Total	38	54	45
Molar root number			
2	22	33	30
Root number other than two	0	1	1
Total	22	34	31

Table 8: distribution of lower root traits.

	Double Rooted Mandibular Canine	Tomes Root (mandibular pre-molars)
Absent	37	18
Present	3	2
Total	40	20

Other traits

Enamel extensions are, 'projections of the enamel border in an apical direction' (Turner *et al.*, 1991). Enamel pearls are isolated globules of enamel found on molar root surfaces. Three cases of enamel extensions were observed in three individuals (50167, 50632, 59053) from the Whitby population. 50167, a juvenile also had the only instance of enamel pearls present on the lingual surface of the mandibular left and right second molars.

Retained deciduous teeth in adults are usually the result of an eruptional anomaly of the underlying permanent dentition (Hillson, 1996). There were five retained deciduous teeth present in five individuals. There is evidence that a sixth individual may have retained their deciduous left upper m2; the retained tooth is not present however the individuals (59005, unsexed 25-35) left upper PM2 appears to be un-erupted.

Microdontia is a reduction in tooth size, most commonly affecting a single tooth within a dentition. The maxillary second incisors and third molars are the teeth which most often exhibit microdontia (Alexandersen and Nielsen, 1970). Size reduction was observed in six teeth from five individuals;

Table 9: showing reduced teeth

Skeleton No.	Position of reduced tooth
50332	Maxillary left I2
50369	Maxillary I2
50451	Both maxillary M3s
50620	Maxillary right I2
59001	Maxillary right M3

TOOTH PATHOLOGY

No pathology was found effecting juvenile dentition. The pathology reported below is that found in adults.

Caries

Dental caries (or cavities) occur when the acid by-product of bacteria in dental plaque causes focal destruction in the tooth (Hillson, 1996). Dental caries were scored as present or absent.

There were 136 adults with one or more teeth present and of these 21 were found to have caries. Caries presence by tooth is shown below:

Table 10: distribution of caries by tooth

Maxillary

	LM3	LM2	LM1	LPM2	LPM1	LC	LI2	LI1	RI1	RI2	RC	RPM1	RPM2	RM1	RM2	RM3	Total
Teeth Present	51	68	54	55	68	67	56	56	51	49	73	62	65	56	75	69	975
Caries	1	3	0	0	0	0	0	2	0	0	1	0	1	0	4	0	12
Teeth present	61	77	69	63	72	69	55	52	48	54	86	83	67	68	78	55	1057
Caries	2	2	4	2	0	1	0	0	0	0	0	1	1	3	4	2	22

Mandibular

The results show that caries was present in 15.4% (21/136) of adults scored and 1.67% (34/2032) of teeth. Below is a comparison of the caries presence at Whitby with other contemporary sites:

Table 11: comparison of caries cavities between sites.

Site	Date	% caries per tooth	% caries per individual
Whitby	7^{th}-9^{th} century	1.7	15.4
Norton	6^{th}-7^{th} century	3.4	-
West Heslerton	5^{th}-7^{th} century	2.4	15.5
St Helen-on-the-Walls	10^{th}-16^{th} century	6.1	-
Wharram Percy	10^{th}-19^{th} century	10.3	67.8

The frequency of individuals with caries at Whitby and West Heslerton is very similar. The frequency of caries by tooth is roughly even at Whitby, Norton and West Heslerton, which are all Anglo-Saxon period sites whilst the sites of mainly medieval dates St Helen-on-the-Walls and Wharram Percy have a much higher proportion of teeth effected by caries.

Where caries were observed in molar teeth their location was recorded:

Table 12: distribution of caries cavities in molar teeth

Location of Caries	No. of Molars effected
Root	2
Cemento-enamel Junction	10
Occlusal Surface	0
Gross (origin of caries is not discernable).	13
Side of Crown	0
Total	25

Gross caries cavities were the type most often observed, and where the origin of the caries cavity could be ascertained they were most often found at the cemento-enamel junction. This pattern is typical of populations showing high attrition; as the molars wear down there are less crevices on the occlusal surfaces to trap food debris (Mays, 1998).

Ante-mortem tooth loss

Ante-mortem tooth loss was scored as present or absent where one or more the tooth sockets could be observed:

Table 13: distribution of tooth loss by socket

Maxillary

	LM3	LM2	LM1	LPM2	LPM1	LC	LI2	LI1	RI1	RI2	RC	RPM1	RPM2	RM1	RM2	RM3	Total
Sockets Present	1	0	1	2	1	2	1	0	2	0	1	0	1	1	0	1	14
Tooth Loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sockets present	8	11	14	10	7	8	7	7	6	7	10	8	14	18	19	12	166
Tooth Loss	3	1	3	1	0	1	1	1	1	0	0	0	1	4	3	2	22

Mandibular

Ante-mortem tooth loss by individual was found to be 37.5% (9/24), with a frequency of 12.2% per tooth socket. There were significantly more mandibular tooth sockets available for observation than maxillary sockets, representing the more robust nature of the mandible in comparison to the maxilla. The differential preservation of the maxilla and mandible is an illustration of the poor preservation observed at the site.

Periapical Voids

Periapical voids have in the past been referred to as abscesses, granulomas and cysts. However recent work has highlighted the tendency for these terms to be applied indiscriminately to voids found in association with the tooth root without taking into account the cause of the void or its effect on the individual (Ogden, 2008).

Periapical voids were scored where individuals had one or more tooth sockets available for examination:

Table 14: distribution of periapical voids by socket

Maxillary

	LM3	LM2	LM1	LPM2	LPM1	LC	LI2	LI1	RI1	RI2	RC	RPM1	RPM2	RM1	RM2	RM3	Total
Sockets Present	1	0	1	2	1	2	1	0	2	0	1	0	1	1	0	1	14
Periapical Voids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sockets present	8	11	14	10	7	8	7	7	6	7	10	8	14	18	19	12	166
Periapical Voids	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Mandibular

0.5% (1/180) of the tooth sockets examined exhibited periapical voids; voids were found in 4.2% (1/24) of individuals scored. The single periapical void present was found at the $M1_L$ and was identified as an abscess using the criteria of Ogden (2008).

Calculus

Calculus is mineralised plaque and is considered indicative of low oral hygiene (Hillson, 1996). Calculus was graded using the criteria of Dobney and Brothwell (1987) and the results are shown below:

Table 15: distribution of calculus at Whitby

		Frequency	Percentage
Calculus Grade	0	54	33.3
	1	73	45.1
	2	23	14.2
	3	8	4.9
	4	4	2.5
	Total	162	100.0

66.7% of the Whitby population was graded positive for the presence of calculus, with the majority at low levels. This is roughly similar to the findings at St Helen-on-the-Walls where 73% of individuals had calculus deposits. The Whitby findings are significantly lower than Wharram Percy where 89.2% of individuals had calculus but significantly higher than West Heslerton where only 41.6% of individuals were effected. It is possible that the adverse soil conditions at Whitby destroyed some calculus deposits and that the presence of calculus has been under represented.

Linear Enamel Hypoplasia

Linear enamel Hypoplasia's (LEH) are transverse bands of deficient enamel thickness on the crown of the tooth, which develop during crown formation. They occur as a result of stress upon the growing individual and have been linked to disease and malnutrition (Hillson, 1996; 166). LEH was observed in thirteen individuals from Whitby, the majority occurring in the anterior dentition. Two individuals had twelve teeth which were affected. The number of teeth affected in each individual is shown below:

Table 16: distribution of LEH in adults with one or more anterior teeth present

Number of teeth effected	Number of individuals	% of Individuals
0	109	89.3
1	2	1.6
2	6	4.9
3	0	0
4	0	0
5	3	2.5
6+	2	1.6
Total	122	100

BONE PATHOLOGY

Due to the poor preservation of the skeletal remains, bone pathology could not be systematically recorded, however a few cases were noted.

Osteoarthritis (OA) is degeneration of the joint surfaces causing osteophytosis of joint margins, surface porosity and eburnation. OA occurrence is known to increase with age and is thought in part to be a result of mechanical loading stresses on joints.

The severity of OA was scored using a system adapted from Sager (1969, in Brothwell, 1981; 150):

Grade 0 Normal bone surface
Grade 1 Intermittent osteophytes
Grade 2 Surface porosity; may be accompanied by osteophytes
Grade 3 Eburnation; may be accompanied by porosity and osteophytes

Three individuals in the Whitby population exhibited osteoarthritic changes:

Table 17: cases of osteoarthritis observed in the Whitby population

Skeleton no.	Grade of osteoarthritis	Location effected
A4 (adult male)	2	Distal left femur Distal right femur
50408 (probable female, 50+)	3	Cervical vertebra
50495 (unsexed, 35-45)	1 2 3	Proximal left first metacarpal Unsided hand phalange Left femur head

Cribra orbitalia is recognised in dry bone as localised pitting and perforation of the orbital roof and was found in two individuals from Whitby. Skeleton 7001(probable female, 25-35) had cribrotic cribra orbitalia in the left orbit, whilst 50338 (male, 17-25) had porotic cribra orbitalia effecting both orbits (Brothwell, 1981; 165).

Cribra orbitalia is most often a result of anaemia. It is recognised that the cause of the anemia is linked not only to dietary deficiency but also factors such as parasite load, pregnancy and blood loss which effect the uptake of nutrients such as B12 and iron into the body (Stuart-Macadam, 1992; Walker *et al.*, 2009).

The single example of trauma found was individual 7001 (probable female, 25-23), who had a partially healed fracture present on the shaft of an unsided metacarpal.

Two individuals exhibited non-specific infections causing periostitis; changes to the surface of the bone often as a response to inflammation of the overlying soft tissue (Ortner, 2003; 206). 50193 (male, 45+), has new bone formation along the anterior crest of the right tibia. The bone formation is both unremodelled and remodelled indicating a chronic condition. Evidence of periostitis is also present on the right fibula of this individual.

59021 (unsexed, 25-45) has unremodelled new bone formation along the anterior crest of the right tibia and both remodelled and unremodelled new bone formation along the anterior of the left tibia. The presence of both remodelled and unremodelled lesions affecting both tibiae is suggestive of a chronic systemic condition. The highly fragmentary nature of both burials makes it impossible to ascertain the extent or distribution of the lesions and their cause cannot be determined.

CREMATED BONE

A single cremation (50357) was recovered. The human remains from it weighed 1132.5g with an average fragment size of about 37mm. The colour of the cremated bone varied widely; black and white predominated but reddish-brown and greys were also present. No juvenile remains were identified. Identifiable bone fragments established that a minimum of two individuals are represented in the cremation. Two right and two left petrous portions of temporal bone were recovered (see plate 1), and there are a large amount of femur fragments present, some of which are very robust and others which are much less so, suggesting they are not from the same individual. The morphological characteristics of skull fragments indicate one of the individuals is male (White and Folkens, 2005); no sexually diagnostic elements are present from the other individual.

Analysis of cremated adults from the Romano-British site of Godmanchester, showed the mean weight of a single cremation at the site was 678.3g, with a range of 24.9-1405.7g (Mays, 1993). If we assume that the total weight of bone in the Whitby cremation is equally divided by the two individuals identified, each has 566.3g present which is slightly lower than the mean weight of cremations seen at Godmanchester. A complete cremated adult skeleton weighs between 2-3g (Mays, 1993) and the weight of bone recovered from archaeological contexts represents the recovery of bone after cremation as opposed to the size of an individual (McKinley, 2000). Adverse soil conditions effect cremated less the inhumed bone and it is unlikely that the soil conditions at Whitby caused much loss of cremated material.

Comparison of duplicated femur fragments show colour differentiation between robust and gracile fragments (see plates 2 and 3). The predominant colour of the more robust fragments is black, whilst the more gracile fragments are white. It has been shown that colour change in burnt bone is roughly indicative of cremation temperature; a study by Mays (1998) showed that bone turned black at 285°C, grey/brown at 440°C and white over 645°C. The more robust fragments are mostly black with some brown and light grey colour changes suggesting the bone was exposed to temperatures between 285°C and 645°C. In contrast to this the less robust fragments are mainly white, with some grey areas suggesting they were exposed to minimum temperatures of 645°C. The exposure of the two individuals to different temperatures suggests that their cremations may have been separate events, following which their remains were brought together for deposition.

It is thought probable that the cremation pre-dates the inhumations on the site and is possibly prehistoric or Roman in date. Radiocarbon dating is currently under way to establish a date for the cremation deposit.

INVESTIGATION OF SAMPLING

Introduction

During trial trenching of the Whitby cemetery site it was realised that the human remains recovered during excavation were likely to be very badly preserved. Prior to lifting some skeletons appeared to be quite robust, however the soil conditions (boulder clay) had degraded the bone causing it to fragment upon excavation. Material recovered from graves varied, in some cases relatively large amounts of highly fragmented bone was recovered and in others only tooth enamel remained (see plates 4-9). Soil staining was often observed surrounding fragmentary remains and in some cases this staining was the only observable evidence of a skeleton. It was also noted that the grave cuts were often difficult to distinguish.

Before excavation of the site commenced, a sampling regime was put into place to allow the opportunity of quantifying the effectiveness both of sampling and of varying processing techniques on the recovery of remains. This chapter is divided into two sections which deal with processing methods used on the Whitby samples and the recovery of skeletal material from the site.

Methodology

Prior to the start of the 1999 and 2000 excavations site staff were briefed on the nature of the study and the importance of consistently following the methodology. Staff were instructed to collect all visible material in the graves by hand, where possible collecting skeletal elements (e.g. left hand, right hand etc) separately. The soil remaining in the grave was then to be sampled using one sample number with three sub-samples; A (head area), B (torso/pelvis/arms and hands) and C (legs and feet). There was no maximum sample size stipulated, rather all soil surrounding and beneath visible remains or soil staining was collected.

Sample pre-treatment

Only a small amount of burial samples were processed on-site during the 1999 season with the result that a backlog of samples needed to be processed off-site. The combination of the clay soil at Whitby and the time lapse between sample collection and processing meant that samples were time consuming to process, as the soil was difficult to break-up. To address this problem a test program was instigated by the environmental team, to establish whether pre-treatment of the samples could decrease processing time by breaking up the clay soil. The full results of the study are presented elsewhere; this section will examine the effects of the differing pre-treatments on the bone recovered.

The ‘C’ sub-samples from forty burials were used in the trial. The unprocessed samples were subjected to one of three pre-treatments; soaking in water (Water), four freeze-thaw cycles (Freezer) or soaking in water to which 200ml of anhydrous sodium carbonate (Sodium Carbonate) had been added. The numbers of samples using each treatment are shown below:

Table 18: use of sample pre-treatment

		Pre-treatment.		
		Water	Freezer	Sodium Carbonate
Total weight of 'C' samples (g).	Total N	12	15	13
	Mean	77.60	114.60	105.68
	Median	28.30	31.00	32.70
	Variance	15898.89	40910.13	28636.78
	Standard Deviation	126.09	202.26	169.22
	Minimum	.00	.00	2.90
	Maximum	439.20	754.60	567.50
	Range	439.20	754.60	564.60

The average amount of bone recovered from the samples subjected to each pre-treatment was compared, in order to establish whether this effected bone recovery. Statistical comparison shows no difference in the weight of bone recovered from samples between pre-treatments (using Kruskal-Wallis [non-parametric analysis of variance], H=.338, df=2, Asymp. Sig.=.845).

To establish if the pre-treatment had an effect on the fragmentation of bone the ratio of 8mm/4mm fragments recovered from different pre-treatments was compared.

Graph showing the weight of 8mm sample against weight of 4mm sample

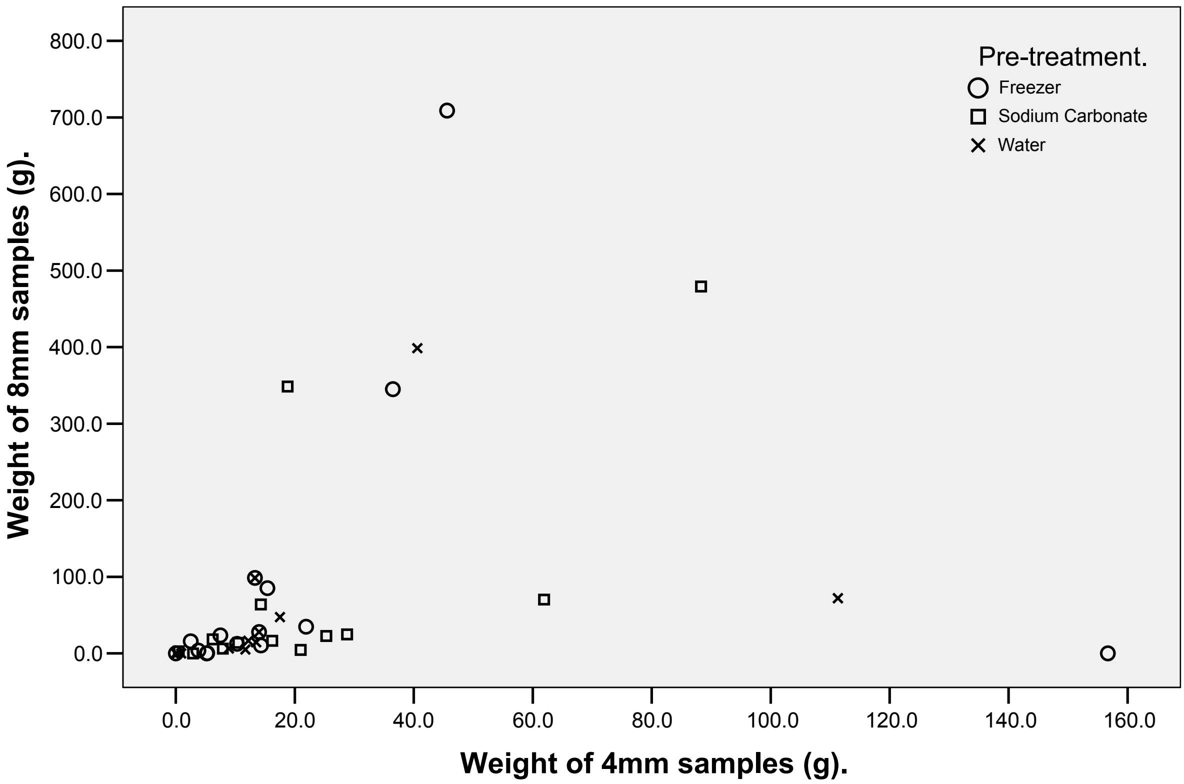


Table 19: effect of pre-treatment on bone recovery

		Pre-Treatment		
		Water	Freezer	Sodium Carbonate
8MMC	Mean	57.3	91.1	82.4
	Standard Error of Mean	32.3	49.6	41.9
	Median	15.5	15.8	18.3
	Standard Deviation	112.0	192.2	151.1
	Percentile 25	2.6	.4	6.2
	Percentile 75	59.8	85.2	63.8
	Range	398.6	709.0	479.2
4MMC	Mean	20.3	23.5	23.3
	Standard Error of Mean	8.8	10.1	7.0
	Median	12.8	13.3	16.2
	Standard Deviation	30.6	38.9	25.1
	Percentile 25	4.9	5.2	7.9
	Percentile 75	15.8	21.9	25.3
	Range	111.3	156.7	87.8
Ratio: 8mm/4mm	Mean	2.38	3.85	3.31
	Standard Error of Mean	.97	1.21	1.37
	Median	1.07	1.79	1.13
	Standard Deviation	3.23	4.54	4.96
	Percentile 25	.44	.72	.86
	Percentile 75	2.71	6.32	4.46
	Range	9.82	15.55	18.54

As can be seen on the graph above the distribution of fragment size within the samples does not seem to vary between pre-treatments and statistical analysis of the ratio of weight of 8mm/4mm samples confirms this (using the Kruskal-Wallis test [non-parametric analysis of variance], H=.809, df=2, Asymp. Sig.=.667).

The trial found that soaking the samples in water with sodium carbonate was the pre-treatment which was most efficient at breaking up the soil. The remaining unprocessed samples from the 1999 season and all samples from the 2000 season were pre-treated in this way. As analysis shows that the different pre-treatments had no effect on the recovery or fragmentation of bone, it is not necessary to exclude burials which were used in the pre-treatment test from the analysis of the recovery of skeletal material.

Recovery of skeletal material

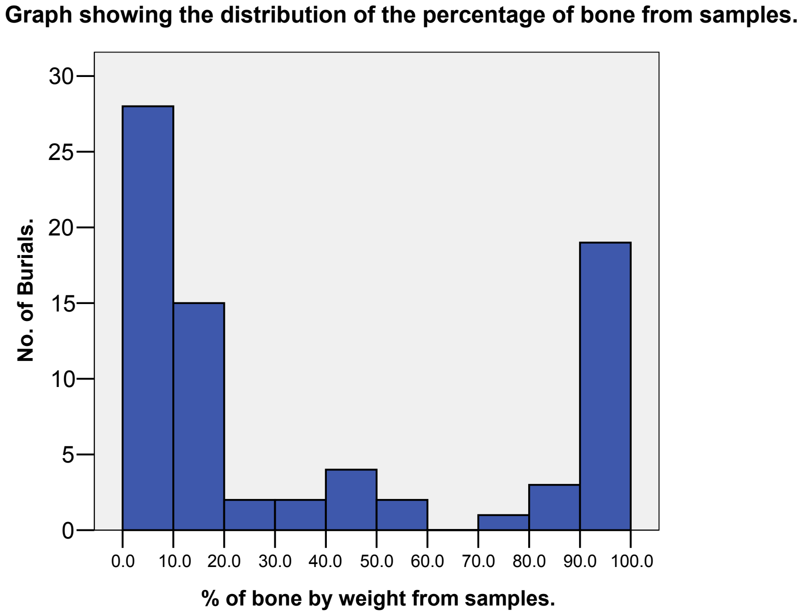
During the 1999 excavation season, samples were passed through a column of 4mm and 2mm meshes. Interim analysis was undertaken by Dr S Mays on 2mm samples from 46 burials and found no identifiable bone fragments in the material which passed through the 4mm sieve but was retained by the 2mm mesh. Subsequently in the 2000 excavation season sorting of bone the 2mm mesh was discontinued and after consultation with site staff an 8mm mesh was introduced in addition to the 4mm mesh to increase the speed at which samples were processed. After sieving the 8mm and 4mm material was hand sorted, while the 2mm residues were retained for osteological examination.

In the laboratory each sub-sample was weighed and the identifiable fragments were recorded. Bone fragments were counted as identifiable if they could be identified to an element (e.g. femur as opposed to long bone) but not necessarily side and divided into categories; skull (inc. mandible), long-bones, other element. Teeth were classed as identifiable if they could be assigned to a specific position in the dentition (e.g. upper second right molar as opposed to just molar). The 2mm residues were examined for any identifiable bone fragments, however as identifiable material was only present in 1/136 samples no further analysis was done on this material. Juveniles were excluded from statistical analysis, as were burials where the full complement of samples was not taken and those where on-site records indicated the possibility of truncation of the grave cut by another feature. This produced a data set of 76 burials for statistical analysis. The analysis looked at several factors including the amount of additional bone which was recovered through sampling and the success of the differing sieving regimes in recovering information.

It was expected that sampling would increase the amount of skeletal material recovered in comparison to hand collected material and that the presence of a large amount of hand collected material may suggest better bone survival than if the amount of hand collected bone was low. In this case a positive relationship may be expected between the amounts of hand and sample collected bone. It will be desirable to look at an index of fragmentation of the skeletal material to ascertain how comminuted the remains are. It was anticipated that the amount of identifiable material recovered would increase when samples were taken and that identifiable fragments would be more routinely found in the 8mm samples than the 4mm samples. However the number of loose teeth recovered from site is likely to affect this relationship so teeth and bone are considered separately during analysis.

Analysis

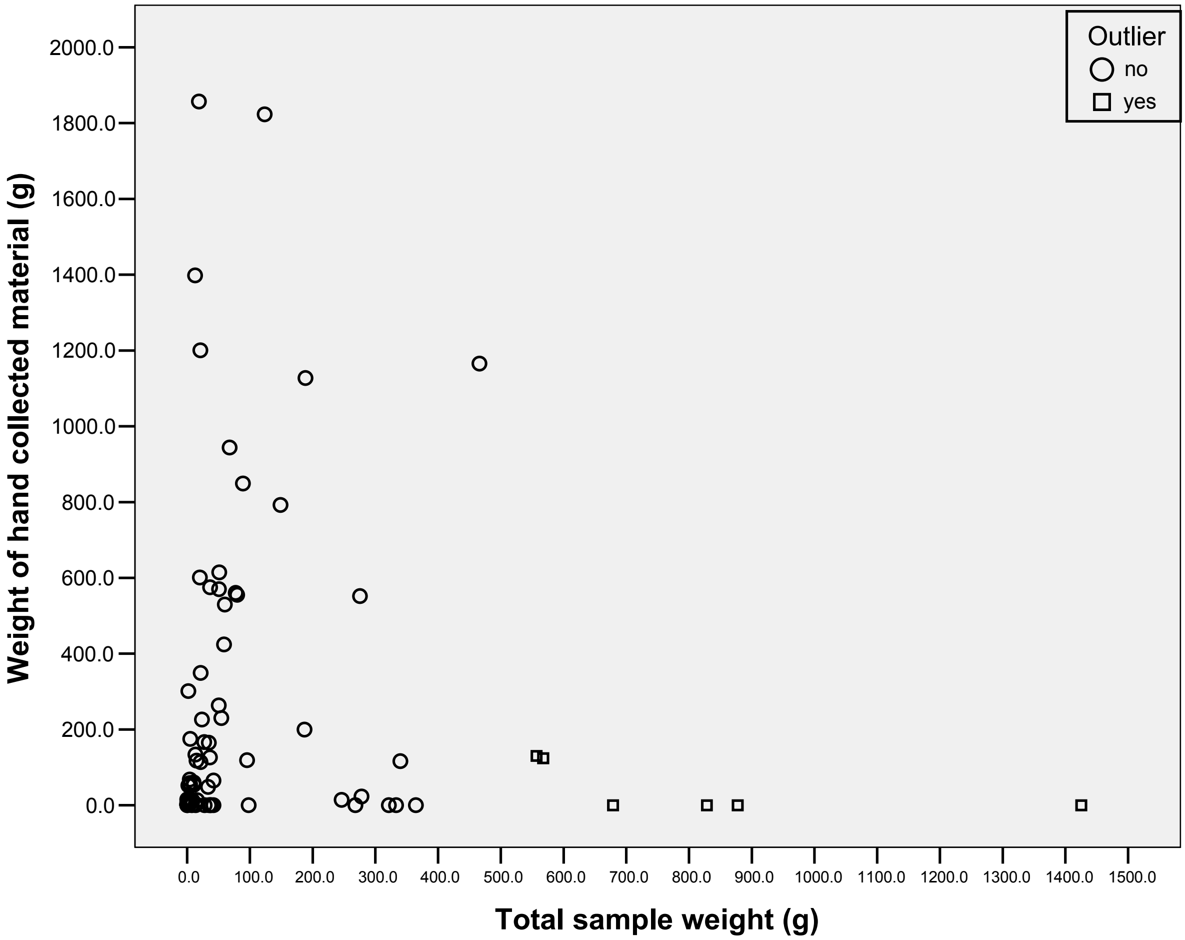
The first part of the analysis was to establish if the sampling had produced an increase in the amount of bone which was recovered from each skeleton. Of the 76 burials forming the statistical group, bone was found in the samples of 90.8%. The graph below shows the percentage by weight of the total bone from samples per burial;



The variability in the percentage of the total skeletal weight recovered from samples may either be the result of variability in the preservation of skeletal material across the site or variation in the fragmentation of the skeletal material.

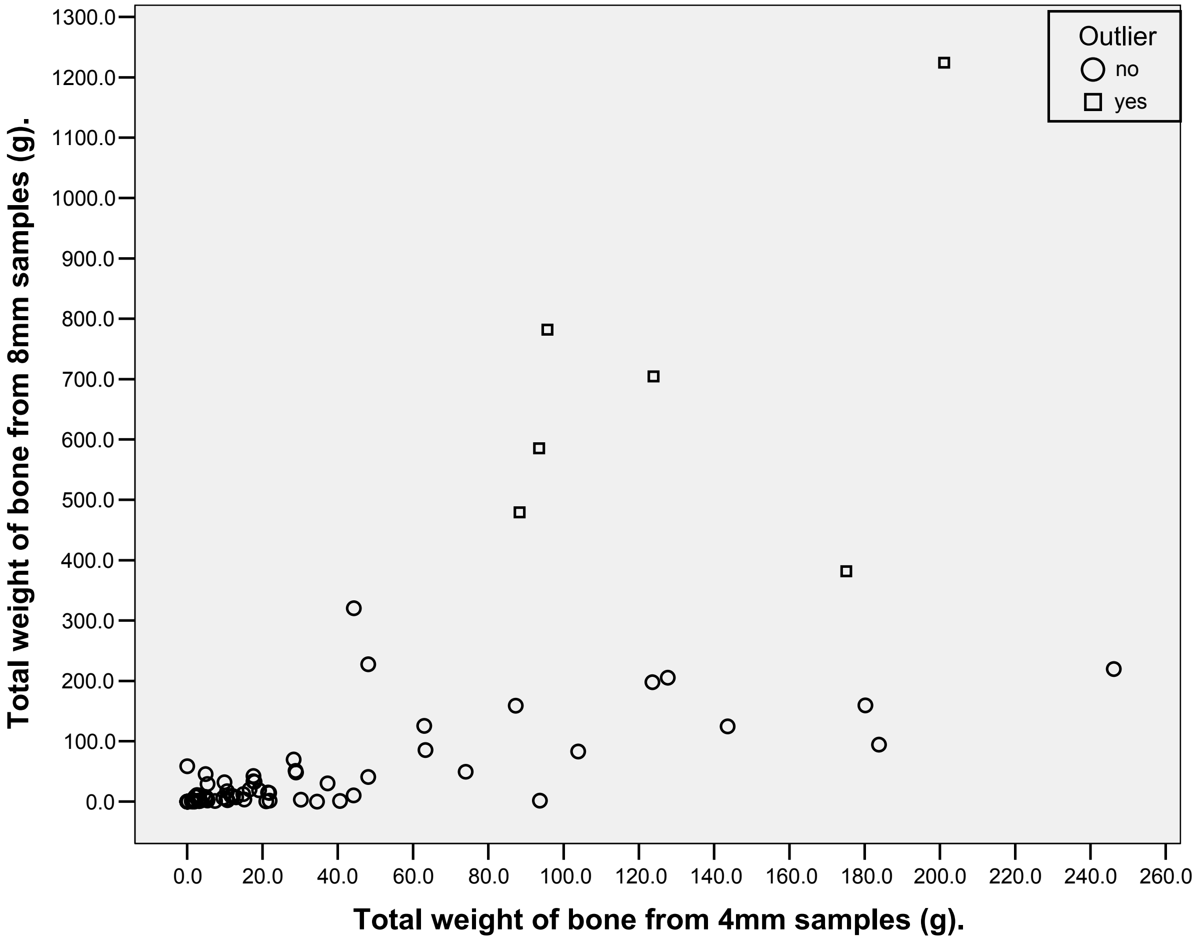
In order to establish the level of preservation at Whitby the relationship between the amounts of hand and sample collected bone was examined. It was expected that good preservation would be reflected by a positive relationship; as the amount of hand collected material increased so to would the amount of material in the sample.

Graph showing the weight of hand collected bone against the weight of bone recovered from all samples.



The positive relationship which was anticipated is clearly not the pattern shown on the graph, which seems to show a more inverse relationship i.e. as the amount of hand collected bone increases the amount of sample collected bone decreases. To test this relationship Y=1/x was plotted and the results tested for correlation using Spearman's correlation coefficient. Six possible outliers are shown, in which the weight of material retrieved from samples is large whilst the weight of hand collected material is either very small or non-existent. This may represent burials which had survived in a severely fragmentary state or may indicate that thorough hand collection did not take place on-site. If the latter is the case then it may be expected that the weight distribution within the samples may be unexpectedly skewed towards the 8mm samples, reflecting the fragments which were large enough to warrant hand collection. It was considered that the disproportionate clustering of cases around the origin would give a false impression of the correlation. To combat this, the outliers and cases with a total weight of >20g were excluded. No correlation was found (using Spearman's coefficient correlation, correlation coefficient = .053).

Graph showing the weight of bone from 8mm samples against the weight of bone from the 4mm samples.



When the 8mm/4mm relationship is plotted the same six outliers appear as were seen in the hand/sample collected plot. These show a higher amount of bone from the 8mm sample than the other burials. Comparison of the two groups shows that there is a statistical difference in the ratio of 8mm/4mm weight between the main group and the possible outliers (using the Mann-Whitney test, exact sig. =.000). This makes it seem likely that these outliers represent burials in which thorough hand collection did not take place before sampling was conducted.

Analysis of the data using Spearman's correlation co-efficient found a positive correlation between the weight of 8mm and 4mm bone collected (correlation co-efficient .784). The graph shows that the data is heteroscedastic, with a large cluster of points around the origin (representing the least well preserved burials); however when this is corrected for a positive correlation was still found.

The analysis has shown that sampling increases the amount of bone recovered from burials, however it is important to investigate whether the sample collected bone added to the amount of identifiable bone recovered. Forty-nine of the seventy six burials examined contained identifiable material in at least one sample, showing an increase in the recovery of identifiable fragments when sampling was used.

It is now desirable to establish what effect the different sieve sizes used had on the retrieval of fragments. Comparisons of the amount of bone which was retained by the 8mm and 4mm sieve show that there is no significant difference between the two:

Table 20; comparison of the weight of bone (g) retained by the 8mm and 4mm sieves.

		N	Mean Rank	Sum of Ranks
Total of all 4mm samples - Total of all 8mm samples	Negative Ranks	30[a]	46.53	1396.00
	Positive Ranks	39[b]	26.13	1019.00
	Ties	7[c]		
	Total	76		

a. Total of all 4mm samples < Total of all 8mm samples

b. Total of all 4mm samples > Total of all 8mm samples

c. Total of all 4mm samples = Total of all 8mm samples

(Using the Wilcoxon signed ranks test, exact sig.=.262). Although similar amounts of skeletal material were retained by the 8mm and 4mm sieves, it may be anticipated that the material retained by the 8mm sieve will contain more identifiable fragments. However when we compare the number of cases which yield identifiable fragments it is shown that there is no statistical difference between the two sieve sizes:

Table 21; no. of burials containing identifiable material in the 8mm sample compared to the 4mm sample

	ID frags 4mm	
ID frags 8mm	No	Yes
No	27	8
Yes	18	23

(Using the McNemar test, exact sig.=.078). One circumstance which may account for this is the number of loose teeth which were recovered from the site, with burials regularly recorded in which tooth crowns were the only discernable skeletal remains. If it is the case that identifiable tooth fragments are passing through the 8mm sieve into the 4mm sieve, then the results will reflect this. In order to establish whether this is the case we can compare the amount of hand and sample collected material with identifiable fragments, excluding those cases where teeth were the only fragments which were identifiable. When the teeth are excluded we find the difference between the identifiable fragments in the 8mm and 4mm divisions is highly significant:

Table 22; no. of burials containing identifiable material in the 8mm sample compared to the 4mm sample (excluding teeth).

8MM ID frags excluding teeth	4MM ID frags excluding teeth	
	No	Yes
No	43	2
Yes	29	2

(Using the McNemar test, exact sig. =0), with the majority of the identifiable bone fragments coming from the 8mm sample. However when we reverse this situation and test the differences using only teeth it is shown that there is no statistical difference:

Table 23; no. of burials containing identifiable material in the 8mm sample compared to the 4mm sample (excluding bone).

8MM ID frags excluding bone	4MM ID frags excluding bone	
	No	Yes
No	35	14
Yes	11	16

(Using the McNemar test with binomial distribution, asymp. Sig. =.845) and the 8mm and 4mm sieve sizes retained similar amounts of identifiable teeth. Below is a contingency table showing the burials which had identifiable teeth or bone fragments:

Table showing the No. of identifiable teeth and bone fragments found in the hand collected and sampled material

	Identifiable Teeth		Identifiable bone	
	No	Yes	No	Yes
Hand Collected	33	43	36	40
8mm	49	27	45	31
4mm	47	29	72	4

This shows that the number of burials containing identifiable bone fragments drops as the sieve size decreases, while the number of burials which contained identifiable teeth remains the same. This illustrates that the 4mm sieve was more efficient at recovering identifiable teeth than identifiable bone.

We can examine the distribution of identifiable fragments further by breaking them down into more specific categories:

Table 24; distribution of identifiable fragments by category

		Skull	Long-bone	Other	Teeth
Hand Collection		31	29	12	43
8mm	A	20	0	2	25
	B	3	3	9	4
	C	0	7	4	0
4mm	A	3	0	1	27
	B	0	0	1	11
	C	0	0	0	0

Loose teeth were the element most often identified in both hand and sample collected material and as would be expected, identifiable teeth were most frequently found in the 'A' sub-samples. However a number of 'B' samples were also found to contain teeth, which may be due to the displacement of teeth during the fragmentation of the skull or the collection of the remains of the mandible and lower dentition as part of the 'B' as opposed to the 'A' sample. In the 8mm sample, skull fragments were found in more samples than any other element and as expected the majority of these were 'A' samples. The presence of skull fragments in so many samples may not necessarily indicate preservation of the skull was better than that of other elements, but is rather an indication that skull fragments are more easily identifiable than other elements. Identifiable long bone fragments were absent from the 4mm samples altogether, representing the difficultly in identifying such fragments to skeletal element. 'Other' skeletal elements were only identified in two samples at 4mm's indicating that smaller hand and foot bones did not survive the Whitby soil conditions.

The overall trend shown is that identifiable bone fragments become less frequent the further from the skull the sample is taken and the smaller the sieve size that is used to collect the material. The number of burials containing identifiable teeth fragments does not alter significantly between sieve sizes. No teeth were recovered from the 'C' samples.

Limitations

Analysis has identified six cases where complete hand collection of skeletal material may not have been carried out before sampling took place. This demonstrates that informing and involving site staff in the project design ensures good practice is followed, whilst showing that on-site conditions cannot always be anticipated. However only a small number of cases were affected by this issue and it has not impacted the outcome of the study.

Discussion

As predicted, sampling did retain more skeletal material than hand collection alone. However the relationship between hand and sample collected material was not as anticipated and it has been shown that no correlation exists between the amounts of skeletal material recovered by hand and sample collection. The amount of identifiable material recovered was shown to increase when samples were taken. The relationship between the numbers of burials containing identifiable material in their 8mm samples in comparison to the 4mm samples was an interesting one. The number of samples containing identifiable bone fragments decreased as the sieve size decreased, however the number of samples containing identifiable teeth remained constant as the sieve size decreased. Only two samples were found to have identifiable 'other' material retained by the 4mm sieve indicating poor survival of small elements such as phalanges.

Conclusions

Analysis showed that sampling of fragmentary burials not only recovers a greater quantity of bone, but that sampling yields additional osteological information. In light of the findings recommendations for future excavation of fragmentary remains are that samples should be taken from the entire grave if possible and the skull and upper chest area at a minimum. Samples should be processed by passing material through a 4mm sieve to ensure that as much useful osteological data as possible is recovered and it is suggested that the addition of an 8mm sieve will increase the speed at which samples can be processed. While the study has established that the use of a 2mm along side a 4mm sieve does not increase the recovery of identifiable elements it may still be a useful addition where the research aims require an accurate weight of the burial to be recorded.

CONCLUSION

225 inhumations and one cremation were examined. 175 adults, 28 juveniles and 22 individuals of unidentifiable age and sex were recovered. Of the adults few inhumations could be sexed, although the majority could be aged.

All the inhumations consisted of highly fragmentary bone, and because of this analysis concentrated on the non-metric traits of the dentition. Dental non-metrics are not regularly reported in osteological reports on well preserved material and comparison of the Whitby skeletons with other contemporary populations has not been possible for this reason. The results of our findings are reported here so they may be used as a comparison for further research on poorly preserved remains.

Where the frequency of dental pathology in the Whitby population was suitable for comparison it was found that a similar percentage of cases were observed at contemporary sites. Few instances of pathology were identified due to the fragmentary nature of the remains.

The poor condition of the remains allowed exploration of excavation methodology, resulting in recommendations for the recovery of fragmentary human remains from archaeological sites.

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PLATES

Plate 1: duplicated petrous portions of the temporal bone from cremation (50357).

Plate 2: contrasting colours of femur fragments

Plate 3: difference in cortical widths between femur fragments

Plate 4: skeleton 50531 prior to lifting

Plate 5: hand collected material from 50531

Plate 6: sample collected material from 50531. 8mm fragments on the left, 4mm fragments on the right. Samples are divided (top to bottom) into A/B/C sample areas.

Plate 7 (left): skeleton 59078 (poorly preserved) prior to lifting.

Plate 8 (right) hand collected material from 59078.

Plate 9: sample collected material from 59078. 8mm fragments on the left, 4mm fragments on the right. Samples are divided (top to bottom) into A/B/C sample areas.

CATALOGUE OF BURIALS

Skeleton no.	Sex	Age	Total weight (g)
7000	U	ADULT	1511.8
7001	F?	25-35	1666.5
7002	U	25-35	8.8
50070	?	-	45.6
50083	J	7.5	51.1
50084	U	35-45	342.5
50092	U	ADULT	491.8
50118	U	21-25	121.3
50121	U	17-25	1946.3
50122	U	ADULT	421.3
50129	U	ADULT	181.1
50132	U	17-25	546.5
50139	U	35+	408.7
50156	M	35-45	2608.7
50159	U	25-35	703.1
50164	U	35-45	478.2
50167	J	7-12	162.4
50168	M	45+	1490.8
50175	U	25-35	695.9
50178	J	10-12	107.0
50183	M?	35-45	178.8
50184	M?	25-35	738.3
50185	F?	17-25	1806.4
50186	U	ADULT	249.6
50189	U	35-45	784.8
50190	M	50+	1897.3
50193	M	45+	1625.9
50196	U	35-45	833.8
50199	U	25-35	1464.6
50215	M	35-45	1438.6
50222	U	ADULT	163.8
50231	J	7-10	60.0
50233	U	ADULT	47.6
50246	U	17-25	684.4
50248	?	-	1.2
50253	U	ADULT	258.2
50254	?	-	181.7
50258	U	25-35	933.5
50260	J	6-8	21.9
50271	U	25-35	157.5
50272	J	7	12.9
50273	J	7-8	68.9
50279	U	17-25	20.6
50280	F?	17-25	990.2
50286	U	ADULT	207.3
50290	U	25-35	578.9
50295	U	ADULT	175.3
50300	?	-	3.1

Skeleton no.	Sex	Age	Total weight (g)
50304	U	25-35	552.5
50307	J	8-11	27.0
50314	U	17-25	263.0
50320	U	ADULT	456.0
50325	U	25-35	616.0
50331	U	45+	885.2
50332	U	35-45	1631.6
50337	U	17-25	219.3
50338	M	17-25	1875.8
50349	U	17-25	133.0
50350	U	ADULT	81.6
50353	U	17-25	132.9
50354	U	ADULT	814.8
50364	F?	35-45	1140.6
50369	U	12-20	23.1
50370	U	ADULT	728.8
50373	U	17-25	483.1
50378	U	25-35	691.7
50381	U	25-35	420.7
50382	U	17-25	618.4
50383	U	ADULT	173.3
50386	U	25-35	125.0
50390	U	ADULT	132.7
50393	U	ADULT	386.7
50397	U	17-25	303.1
50398	U	17-25	58.3
50402	U	ADULT	237.6
50405	U	25-35	370.5
50406	J	4-6	170.9
50408	F?	50+	2085.4
50409	?	-	29.1
50410	U	25-35	687.0
50413	U	ADULT	141.6
50425	U	35-45	1315.9
50428	U	17-25	621.4
50431	J	10	106.9
50439	U	17-25	634.9
50442	U	17-25	1426.1
50445	U	ADULT	665.7
50449	U	50+	941.3
50451	U	17-25	828.4
50454	U	ADULT	429.5
50455	U	25-35	98.0
50458	U	ADULT	877.6
50466	?	-	41.8
50469	U	25-35	637.5
50492	U	17-25	117.6
50495	U	35-45	1946.8
50496	U	ADULT	34.7
50500	U	17-25	678.9

Skeleton no.	Sex	Age	Total weight (g)
50501	U	ADULT	156.7
50504	U	ADULT	472.4
50507	U	25-35	268.1
50520	U	25-35	146.8
50521	U	ADULT	295.7
50524	U	ADULT	36.8
50528	U	17-25	827.3
50531	U	25-35	1011.4
50534	U	35-45	589.7
50535	U	ADULT	879.2
50539	U	45+	621.0
50545	U	25-35	364.5
50554	?	-	0.1
50557	U	25-35	38.0
50560	U	17-25	225.9
50563	U	17-25	179.8
50566	U	25-35	611.6
50569	U	25-35	938.0
50572	U	17-25	284.5
50575	U	17-25	107.1
50576	U	ADULT	59.6
50579	U	ADULT	562.5
50584	U	ADULT	56.3
50590	U	25-35	393.9
50593	U	ADULT	321.5
50596	U	25-35	301.2
50599	U	17-25	214.3
50602	U	ADULT	333.0
50604	U	25-35	260.5
50608	U	17-25	174.7
50611	?	-	22.4
50614	J	6-11	18.4
50618	U	17-25	108.6
50620	M	25-35	913.7
50621	U	ADULT	838.9
50624	U	25-35	194.1
50629	U	ADULT	190.0
50632	U	17-25	25.7
50635	J	1	6.0
59001	U	25-35	199.5
59002	U	ADULT	313.8
59003	U	35-45	60.5
59004	J	6-10	1.1
59005	U	25-35	10.1
59006	U	25-35	62.4
59008	U	17-25	8.0
59009	U	ADULT	215.3
59010	?	-	5.8
59011	U	17-25	14.5
59012	U	ADULT	72.6

Skeleton no.	Sex	Age	Total weight (g)
59013	U	17-25	16.6
59014	?	-	0.1
59015	U	ADULT	6.1
59016	U	25-35	3.6
59018	U	25-35	54.0
59019	U	50+	1221.8
59020	U	25-35	20.5
59021	U	25-45	1356.9
59022	U	17-25	1410.5
59023	?	-	7.4
59024	U	25-35	398.0
59025	J	6-7	10.7
59026	?	-	1.7
59027	U	17-25	8.6
59028	?	-	0.3
59029	U	25-35	11.9
59030	U	17-25	13.5
59031	U	25-35	1.5
59032	U	17-25	27.7
59033	U	ADULT	193.5
59034	U	50+	262.7
59035	U	25-35	193.9
59036	U	ADULT	473.0
59038	U	35-45	4.0
59039	J	12-20	11.8
59040	?	-	19.9
59041	J	2-3	4.6
59042	J	12-20	139.6
59043	U	25-35	59.2
59044	U	17-25	7.0
59046	U	17-25	72.0
59047	U	17-25	14.8
59048	J	7-12	2.3
59049	J	12-20	4.6
59050	U	17-25	20.5
59051	J	11	8.9
59052	J	6	11.3
59053	U	25-35	162.3
59054	U	ADULT	110.2
59055	U	ADULT	29.0
59057	U	ADULT	75.9
59060	U	17-25	6.0
59061	U	25-35	5.3
59062	J	7	29.2
59064	U	ADULT	256.2
59065	U	25-35	64.1
59066	U	25-35	120.5
59067	U	25-35	70.5
59068	?	-	1.7
59069	?	-	1.8

Skeleton no.	Sex	Age	Total weight (g)
59070	U	17-25	135.1
59071	U	25-35	15.4
59072	U	ADULT	99.7
59073	M	25-35	248.3
59074	U	25-35	58.3
59075	J	8-17	7.0
59076	U	ADULT	150.9
59077	U	ADULT	81.9
59078	U	25-35	20.3
59079	?	-	5.5
59080	?	-	13.7
59081	J	2	3.8
59082	?	-	0.1
59083	U	25-35	5.7
59085	J	8-11	9.4
59086	?	-	0.6
59087	U	ADULT	2.0
59088	U	ADULT	193.9
59090	U	17-25	25.5
59091	?	-	11.8
59092	U	17-25	51.0
59093	J	7-12	17.8
59094	J	7-10	9.2
59098	?	-	0.0
50354A	J	1-2	0.0
A4	M?	ADULT	994.0
E2	U	ADULT	30.7

Raw data is held in the archive.

Appendix 1: notes on individual burials

A4

There is grade two osteoarthritis at the distal ends of both femora (Sager, 1969 in Brothwell, 1981; 150).

7001

There was a partially healed fracture on the shaft of an unsided metacarpal.

The left orbital roof exhibited cribra orbitalia, identified as cribrotic in type using the criteria of Brothwell (1981; 165).

50118

This individual has double rooted upper first and second premolars on both the right and left side.

50168

The lower anterior teeth are worn down to the roots suggesting the individual had an under-bite. Calculus deposits are present on the roots of the anterior dentition indicating continued eruption of the teeth to maintain occlusion with the upper dentition.

50193

There is periosteal bone formation on the anterior crest of the right tibia. The lesion contains areas of active and re-modelled bone formation indicating a chronic condition. Periosteal bone formation is also present on the right fibula, however this bone is very fragmentary and it is not possible to ascertain if the lesion was active at the time of death.

50273

The individual has an unidentified mandibular molar present which has an odd crown formation. There are two small cusps on the anterior of the tooth which do not match any of the commonly reported cusp formations (Hillson, 1996; Turner *et al.*, 1991).

50332

The maxillary right 3rd molar and the mandibular left 3rd molar are submerged and the mandibular deciduous right 2nd molar has been retained. The 2nd maxillary left incisor is reduced in form.

50338

Cribra orbitalia is present on both orbital roofs, which has been categorised as porotic after the criteria of Brothwell (1981; 165).

50364

The individual has a retained metopic suture.

50369

The deciduous left mandibular canine has been retained and a reduced tooth is present which is most likely to be a maxillary 2nd incisor, although the reduction has made siding the tooth impossible.

50397

A retained mandibular deciduous 1st molar is present.

50405

The mandibular 1st right incisor has a notch on the occlusal surface which may be consistent with the use of the tooth as a tool.

50408

One cervical vertebra exhibits grade three osteoarthritis as defined by Sager (1969, in Brothwell, 1981; 150).

50442

There are small, smooth walled foramen like holes on the buccal surface of both maxillary canines, both mandibular canines and the mandibular 2nd left incisor.

50451

Both maxillary 3rd molars are reduced.

50572

The mandibular right deciduous canine has been retained and the permanent left mandibular canine is present and unerupted.

50495

There is grade one osteoarthritis at the left proximal first metacarpal, grade three osteoarthritis at the left femoral head and grade two osteoarthritis on an unsided hand phalange. Grades were assigned using the criteria of Sager (1969 in Brothwell, 1981; 150)

50608

A premolar is present with a malformed crown morphology. The tooth is probably either the maxillary 1st or 2nd right premolar, however the crown morphology does not make it possible for the tooth to be identified further.

50620

The maxillary left deciduous canine has been retained, however the wear present on the permanent maxillary left canine indicates it had erupted. It is possible that the retained canine had taken up the position and appearance of a supernumery tooth. The right maxillary 2nd incisor is reduced in size.

50621

The left distal humerus has a septal aperture present.

50624

The left mandibular 1st molar exhibits a cusp 6, as described in the ASUDAS (Turner *et al.*, 1991) and illustrated by Hillson (1996; 95).

59001

The maxillary 3rd molar is peg-shaped.

59005

The maxillary left 2nd premolar appears to be unerupted, indicating the left maxillary deciduous 2nd molar may have been retained, although it is not present in the recovered material.

59021

There is active periosteal new bone formation along the anterior crest of the right tibia. The left tibia has remodelled new bone formation along the anterior ridge and medial side of the midshaft, along with active new bone formation on the lateral side of the midshaft. The presence of both remodelled and active new bone formation on both bones indicates a systematic, chronic disease as the cause of the lesions.

59046

Both mandibular first molars have a deep curved groove surrounding the disto-lingual cusp.

59067

The mandibular 3rd molar is very unevenly worn and has a mal-formed crown.

59087

There is an unidentified pre-molar present with mal-formed crown morphology.

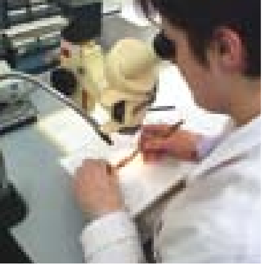
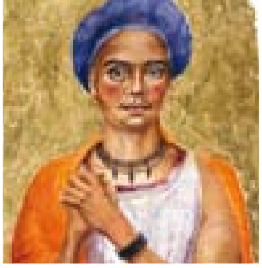
59092

There is a mal-formed tooth present, which is possibly a peg-shaped 3rd molar or a pre-molar. The tooth is unworn and may not have been erupted at the time of death.

APPENDIX 2; RAW DATA.

Skeleton No.	Tooth	Distance from CEJ	Age of occurrence
50175	$I2^L$	6.6	
	$I2_L$	4.6	
	$I1_L$	4.2	
	$I1_R$	4.5	
	$I2_R$	5	
50178	C^R	7.5	
	$I2^R$	7.1	
	$I1^R$	Tooth is broken	
	$I1^L$	6.1	
	$I2^L$	7.2	
	C^L	7.3	
	C_L	8.4	
	$I2_L$	5	
	$I1_L$	4.3	
	$I1_R$	4.4	
	$I2_R$	4.7	
	C_R	8.7	
50332	C_L	Band 2.5-3.8	
	C_R	Band 2.6-3.9	
50337	C_L	Two lines at 3.3 and 4.8	
	C_R	Two lines at 3 and 4.3	
50338	$I1^R$	Two lines at 3.3 and 6	
	$I2^R$	5.4	
	$I2^L$	Tooth is broken	
	C_R	Two lines at 3.1 and 5.3	
	$I2_R$	3.6	
50442	C^R	Two lines at 4.3 and 5.8	
	$I1^L$	5.7	
	C^L	4.3	
	$M1^R$	2.6	
	$M1^L$	2.2	
	$M2^L$	2.4	
	$PM1^L$	0.9	
	$PM2^L$	1.2	
	$I1_R$	5.3	
	$I2_R$	6.1	
	$M1_L$	3.4	
	$M1_R$	2.1	
59002	C^R	2.8	
	C_R	3.6	
59003	$I1^L$	5.2	
59011	C_R	Band 4.6 in width starting 3.5 from the CEJ	
	C_L	Band of similar width	

		however tooth is broken so measurements cannot be taken.	
59020	$I2^L$ C_R	3.9 4	
59024	C_L C_R	4.8 5	
59025	C^L $I1^L$ $I2_L$ $I1_L$ C_L	Three lines at 2, 3.6 and 5 Broken so no measurement can be taken. 3.3 2.4 Broken so no measurement can be taken	
59061	C_L	Two lines 4.6 and 6.4	



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