Osteological Analysis of Cremated Skeletal Remains from Ardsallagh Site 1 (A008/034), M3 Clonee to North of Kells Motorway

Report prepared for Archaeological Consultancy Services Ltd

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1. Introduction

This report contains the results of the osteological analysis of cremated bone recovered at Ardsallagh, Co. Meath. Excavations were undertaken by Archaeological Consultancy Services (ACS) Ltd. as part of the M3 Clonee to North of Kells motorway development. One small deposit of cremated bone was recovered from the site of Ardsallagh 1 (A008/035), which appeared to have been disturbed by post-depositional activity.

ARD1/100 (Ardsallagh 1 sample # **198**) was recovered from the interior of a pottery vessel of probable Late Bronze Age date. The pot (**A008/035:100:001**) was deposited in an upright position with only the base and a small portion of the side surviving. Approximately 50% of the base and 5% of the overall vessel structure remained. The cremation burial was located a short distance north west of the main enclosure ringditch, within which c. 29 inhumation burials were discovered.

The osteological analysis here presented aims to provide an identification and quantification of the cremated bone present, to differentiate (where possible) between animal and human remains, to assess taphonomic effects of thermal alteration and fragmentation, and to assess the age, sex and presence of any pathological conditions in the recovered skeletal material.

2. Materials and Process

The skeletal material was analysed in accordance with the standards recommended by the British Association for Biological Anthropology and Osteoarchaeology in conjunction with the Institute of Field Archaeologists.

The skeletal material was analysed macroscopically and, where necessary, with the aid of light reflective microscopy (x50) for identification purposes. The skeletal material was compared against a reference collection of complete and fragmentary human and European domestic fauna.

All fragments >1 mm diameter were counted in order to assess the level of overall fragmentation amongst the assemblage. Fragments were divided into three size fractions (<10mm, 10-15mm, and >15mm diameter). The number of identifiable specimens (NISP) was recorded, with NISP fragments assigned to skeletal part (element) or taxonomic group. The material was weighed with a high-precision digital laboratory scale, with the mass recorded to the nearest 0.1 gram. An inventory of identifiable skeletal elements was recorded (Appendix 1).

3. Reasons for Analysis and Scope of Reporting

Osteological analysis was carried out to ascertain (where possible) the following:

- Identification and quantification of human bone

- Taxonomic groups present

- Surviving skeletal elements present

- Demographic assessment

- Pathological data

- Total weight of the bone recovered

- Degree of fragmentation

4. Identification and Quantification of Skeletal Material

4.1   Introduction

Cremation was the predominant rite for the disposal of the dead at various phases in Irish pre and proto-history, and up to and including the Hiberno-Norse period; consequently, burnt human bone is frequently encountered in archaeological deposits, in addition to often ubiquitous burnt or charred domestic animal bone waste. Concentrations of burnt or calcined bone recovered from sites are often recorded as 'cremations', and this is generally a misnomer. *Cremation* refers to the burning pyre, or other pyrotechnical structure, and is part of a series of ritual formation processes within the mortuary rite, the nuances of which are still little understood. *Cremation burial* is the deliberate secondary treatment, selection, or manipulation of pyre debris and which may include a significant component of materials other than human bone, including pyre fuel, burnt or unburnt animal bone, soil clasts, and even artefactual remains.

Identification of elements of the human body retained in the pyre debris may give an insight into particular areas or portions of the body which may have been purposefully selected following firing, or taphonomic effects biases such as size-related winnowing of elements. Thus, in determining the nature of pyrotechnical event, accurate identification and quantification of the assemblage is critically important. Often, particularly if the bone fragments are very small (<5mm diameter), it is not possible to identify whether bone is categorically human or animal without recourse to histological analysis. However, a general assessment of the quantity of bone recovered may give an indication of the state of preservation of the associated feature in which the bone was interred or, if recovered from relatively undisturbed context, may provide valuable information regarding the cremation processes. This may relate not only to the efficiency of the pyrotechnology, but also to the collection and secondary deposition of bone after the firing was complete.

4.2   Results

The total amount of bone present in each sample was weighed and subsequently analysed for identifiable fragments. A total of 423 fragments of burnt bone with a

combined mass of 38.4 grams was analysed.. The fragments were identified to skeletal part and taxonomic group where possible and assessed for surface modification. The overall weights, weight of identifiably human bone, and NISP and MNI values are tabulated in table 1 below. A full inventory of skeletal remains from each excavated sample can be found in Appendix 1.

Sample	Total weight	Weight human	% human	NISP	MNI	Taxa
ARD1/100	38.4	11.2	29.2%	18	1	*Homo*

Table 1. Quantification of burnt bone from Ardsallagh 1, showing total bone sample weight (in grams), weight of definitively human subset, percentage weight of human bone to total, number of identifiable specimens (NISP), and taxonomic groups represented. **Taxon key:** *Bos*: Cattle; *Homo*: Human; *Ovis*: Sheep or Goat; *Sus*: Pig.

ARD1/100: The sample yielded two fragments of permanent tooth root (probably derived from a single mandibular molar or canine tooth), eight fragments of fibular diaphyseal shaft, three small portions of cranial vault bone, a small portion of maxilla, a fragment of metacarpal distal head, two ulnar diaphyseal fragments, and the right superior articular facet of the first cervical vertebra (Atlas). Thus portions of the cranial vault, gnathic, axial, and upper and lower appendicular skeletons were recovered, suggesting no apparent bias in body portions within the bone assemblage. The presence of only one individual was indicated.

The small proportion of identifiable human fragments in the sample most likely reflects a high degree of post-depositional disturbance to the cremated burial enclosing vessel (see introduction) with concomitant levels of bone fragmentation (see section 5.2).

5. Taphonomy

5.1   Introduction

A variety of perimortem events and postmortem processes can be inferred from the study of bone colour, surface modification, fragment size, and shape. This investigation is generally referred to as taphonomy. When applied to archaeological assemblages of human or animal bone, taphonomic analysis proceeds from an assessment of surface modification. In general, these are divided into three areas: modification by physical agents, modification by non-human biological agents, and modification by humans; all three vectors can impact upon a cremated bone assemblage. Understanding the taphonomic history of a bone assemblage can be invaluable in supporting archaeological interpretations of sedimentary and burial environment, contextual integrity, truncation of features, cycles of erosion, as well as direct cultural impact on the assemblage itself.

5.2 Bone Fragmentation

High levels of fragmentation are often associated with the process of burning of bone. In this, the cultural processes of burning or cremation are essentially those of dehydration and oxidation in which the bone structure is degraded by the action of externally applied heat. This causes the appearance of fissures in the bone, typically leaving the bone prone to fragmentation along those fissures, and may be broken down into fragments as small as 25mm without any form of external disturbance (McKinley and Roberts, 1993); matrix compression, movement of the bone both during and after the burning process, and post-depositional effects will cause subsequent further fracturing, and reduction in fragment size.

Whilst much attention has been devoted to understanding heat-induced fracturing, controversy surrounds the interpretation of fractures in relation to the whether bone is burned whilst still fleshed, defleshed (green), or dry (degreased). It is now realised that there is no satisfactory method available, based on visual observation of bone, to differentiate the condition of the bone prior to thermal-alteration, with studies often contradictory and lacking any clear standardisation (Correia, 1997).

An assessment of levels of fragmentation within a cremation deposit is essential in assessing the bias imposed by fragmentation on the quality of the data retrieved from the analysis of burnt bone. In general the higher the level of fragmentation the less information the can be extracted from a deposit; fragmentation reduces potential identification to element and taxon, sex, age at death, and pathological assessment, and increases the likelihood of winnowing of bone from the deposit due to sub-aerial processes.

Table 2 summarises the results of the quanitification of cremated bone in the Ardsallagh 1 sample presented by size fraction, weight, and percentage of total weight:

Sample		<10mm	10mm - 15mm	>15mm	Total	Degree of frag.
ARD1/100	*Fragment count*	374	27	22	423	
	Weight (g)	17.2	7.3	13.9	38.4	
	% of total weight	**44.8%**	**19.0%**	**36.2%**	**100%**	**11.0**

Table 2. Quantification of burnt bone fragmentation from Ardsallagh by site, showing fragment count, bone sample weight (in grams), and percentage of total weight, divided by size fraction. The final column lists degree of fragmentation as a function of fragment density (total fragment count/total weight).

ARD1/100 showed moderate fragmentation (11.0 fragments per gram) with the majority of the skeletal material <10mm in diameter, though with a significant portion of the sample >15mm. The largest recovered fragment was 27.1mm in diameter. The majority of fragments were sharp-margined and clean, with no rounding or edge weathering.

5.2   Colouration

Burnt bone displays a wide variety of colours ranging from brown to grey-blue, black, grey, grey-white, and chalk white. Traditionally, colour change has been cited as evidence of firing temperatures (Correia, 1997) ranging from brown/orange (unburnt), to black (charred; *c*. 300°C), through hues of blue and grey (incompletely oxidised, up to *c*. 600°C) to the fully oxidised white (>*c*. 600°C). Colour is also seen as a reflection of organic and inorganic materials associated with the bone or body as it responds to increased temperatures; brown is associated with haemoglobin and/or soil discolouration, black with carbonization of bone in an oxygen-starved state, grey with organic pyrolization, and china white with the final stage of organic degradation and fusion of bone salts (*ibid.*).

The results of the analysis of colour variation (table 3) in the fragments of bone indicate that the deposit contained material that had been exposed to heat at a sufficient temperature (>600°C) in order to completely oxidise the bone with the loss of much of the organic component.

The material from Ardsallagh site 1 exhibits a range of colour variation, with the base colour an off-white light grey. The presence of blue/grey colouration amongst the completely oxidised bone was common. This was generally present along the internal surface of long bones, indicating that the bone was exposed to high enough temperatures to oxidise the outside of the bone cortex, but not for long enough for the internal surface of the bone to oxidise fully.

Sample	Overall colour	Secondary colour(s)
ARD1/100	Light grey to white	Blue/grey (10%)

Table 3. Range of colour variation in Ardsallagh cremated assemblage.

6. Human Skeletal Remains

6.1   Inventory

See Appendix 1.

6.2   Age at Death Assesment

Assessing the age at death of an individual is one of the essential tasks in osteological analysis. Age studies have been used in a variety of situations including: **(1)** identification of the individual (in conjunction with sex determination) as part of forensic cases; **(2)** studying the adequacy of growth of children in a population which is seen as an index of overall community health - poor growth is an indicator of unfavourable developmental conditions, diet or environmental stress; **(3)** understanding age-related social status milestones in life – coming of age, marriage, etc; and **(4)** the construction of demographic profiles in an attempt to understand allochronic and/or diachronic patterning in mortality and funerary practices at the population level.

Academically, the assessment of skeletal age at death (SA) is an area of significant study and debate within osteology. SA should not be viewed as equivalent to chronological age at death. SA reflects the natural growth and development of the body in response to diet, environment and activity, rather than an absolute calendrical age; poor diet can produce delayed maturation and growth yielding a 'younger' skeletal age than real calendar years, and conversely, habitual activity can produce an aged, or 'older', skeleton than in reality. This realisation has profound bearing on many areas of archaeological inquiry with the effect that the criteria utilised in order to age an individual have to be carefully chosen and applied.

During the developmental phase of growth (intra uterine to around 21 years old) SA determination is based upon: **(1)** well-understood and predictable rates for the formation and eruption of the dentition, and growth and ossification of the skeleton which are used to age juveniles (Haaviko, 1970; Scheuer and Black, 2000 and 2004; Smith, 1991); **(2)** in sub-adults the unification or fusion of the bones of the post-cranial skeleton provides a reliable marker within relatively tight statistical margins. However, once growth has ended and adulthood is reached, age determination becomes more difficult as many of the criteria used are reflections of skeletal deterioration and 'wear and tear'; as such they are highly variable in expression, and contextually mediated (İşcan and Loth, 1989; Molleson and Cox, 1993).

No surviving age-defining structures were encountered amongst the Ardsallagh 1 human bone assemblage. This was due to the relatively high degree of fragmentation encountered, and the lack of surviving requisite areas such as complete epiphyseal ends of long bones. However, the overall size of the Ardsallagh human bone fragments, and the presence of closed apices in the recovered tooth root structures, suggests that all the identifiable remains were skeletally adult.

6.3   Sex Assesment

Determining the biological sex of an individual is both a central component of individuated analysis and fundamental to the construction of demographic profiles. Like most primates, humans display a discrete pattern of morphological differentiation between males and females; this is termed sexual dimorphism (SD). Some of these differences are associated with primary sexual characteristics of the reproductive system which includes pelvic morphology, whilst others present a host of inter-related morphological, physiological, and behavioural features that become manifest with the onset of the hormonal surge at puberty. These are referred to as secondary sexual features.

In general, a suite of established criteria are used for sexing adults on the basis of cranial and postcranial characters. These include differentiation in cranial characters (the expression of the nuchal crest, mastoid process, supra-orbital margin and ridge, and mental trigone), differentiation in pelvic morphology (greater sciatic notch, ventral arch, sub-pubic concavity, pre-auricular sulcus, and sacro-iliac articulation), and differentiation in overall size and robusticity including ratios of humeral/femoral head size, dental metrics, and joint surface area. The majority of these characteristics require evaluation of large or integrated skeletal structures, and the statistical efficacy of morphological sex-evaluation becomes less significant with increasing levels of bone fragmentation.

Due to the highly fragmented nature and lack of requisite surviving morphological structures, it was not possible to evaluate the sex of the Ardsallagh 1 skeletal remains.

6.4   Pathology

The study of palaeopathology investigates the evolution and expression of ancient disease processes through time and how human societies adapted to them. In studying diseases in archaeological populations we are primarily looking at those disease vectors that leave characteristic changes or lesions on the bony skeleton. Palaeopathological assessment is generally undertaken for one of two reasons: firstly, to document the expression of skeletal disease process during the life of an individual, and secondly, to understand the demography of such pathologies at the population level and their change through time. The range of diseases commonly encountered and investigated includes: trauma, congenital abnormalities, circulatory disorders, joint diseases, infectious disease, diseases of the viscera, metabolic disease, endocrine disorders, hematological disorders, skeletal dysplasias, neoplastic disease, and various diseases and malformations of the dentition.

Some, such as traumatic lesions, are due to the application of external forces on bone. Expression can range from the effects of crushes, trips or falls, to the impact of edged weapons and blunt force trauma. Others, such as the metabolic disorders, arise through the deficiency of essential nutrients and vitamins or the surplus of toxins; understanding their expression provides good evidence of dietary deficiency or environmental stress.

No pathological lesions were noted in the Ardsallagh 1 assemblage.

7. Summary

	ARD1/100
Type of deposit	Urned burial
Percentage survival	c.5%
Total weight of cremated bone	38.4g
Weight of human bone	11.2g
Maximum fragment size	27.1mm
Degree of fragmentation	11.0 f/g
Efficiency of cremation	Overall colour: white Secondary colour: blue/grey (10%) Efficient >600°C
NISP	18
MNI	1
Age at death	Adult
Sex	Unobservable
Pathology	Unobservable

8. References

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9. Appendix 1: Catalogue of Identifiable Specimens

Site	Anatomical elements	Description	NISP	Taxon
ARD1/100	Tooth	Conjoined fragments of root apex of mandibular incisor or canine	2	*Homo*
	Fibula	Left diaphyseal fragment	1	*Homo*
	Fibula	Unsided fragments (2 conjoins)	7	*Homo*
	Parietal	Squame fragment (endosteal surface)	1	*Homo*
	Parietal	Squame fragment (including potion of superior temporal line)	1	*Homo*
	Occipital	Squame fragment (including portion of lambdoidal suture margin)	1	*Homo*
	Maxilla	Maxillo-nasal fragment	1	*Homo*
	Metacarpal	Distal head	1	*Homo*
	Ulna	Unsided diaphyseal fragments	2	*Homo*
	Atlas vertebra	Right superior articular facet of C1 vertebra including root of transverse process	1	*Homo*