An investigation into the placement of disarticulated human remains into shell middens during prehistory

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Abstract

The aim of this thesis was to critically evaluate the evidence for disarticulated human remains in shell middens, using sites in northwest Europe dating to the Late Mesolithic/Early Neolithic as case studies. Traditionally, disarticulated remains placed in shell middens have been overlooked and assumed to be the result of burial disturbance with little in-depth analysis to the plausibility of this as an interpretation. The research considers whether it is possible to determine that the remains occurred through disturbance to inhumations, and to assess to what extent it is possible to reconstruct the processes of deposition of disarticulated remains.

A new methodology has been developed with specific emphasis on identifying what taphonomic processes may have led to commingled human remains to be found at shell midden sites. Six hypothetical bone profile diagrams are presented, based on differing taphonomic processes known to affect burial remains. These hypothetical diagrams then provide comparative models to assess the evidence presented in the case studies.

Three case studies located on the coast of western Scotland; Cnoc Coig, An Corran and Carding Mill Bay, demonstrate that it is likely that the placement of human remains into ancient shell middens emerged as part of secondary burial practices employed around the time of the Mesolithic/ Neolithic transition, while a Danish case study, Havnø, highlights a potential change in practices occurring from the Mesolithic into the Neolithic. Critically, the close assessment of the disarticulated remains provides strong evidence that disarticulated remains in shell middens are likely to be the result of more complex burial processes than previously thought.

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Preface

I have been interested in death and burial generally since beginning my undergraduate degree in Archaeology in 2003 and I developed a fascination with disarticulated human remains specifically when I undertook my 3rd year dissertation on the subject. I then furthered this interest by looking at burial change and continuity in Britain from the late Upper Palaeolithic to the early Neolithic for my Masters dissertation in 2007. This then led to me seeking PhD funding from the AHRC to investigate the phenomenon of disarticulated remains further. I am pleased to have been given the opportunity to dig on a shell midden in Denmark in order to gain a better understanding of these complex sites. I have combined the knowledge gained during this fieldwork with my interest in human remains to develop the research presented in this thesis.

Acknowledgements

I began this PhD research in October 2010 and this thesis is the culmination of many twists and turns along the way. I would firstly like to thank my husband, Andrew, and my parents, Roger and Denise, for their immense support and encouragement throughout all stages of this research and writing up. In 2013 I took 6 months maternity leave to have my son, Robin. He has provided much needed perspective when the weight of completing this research seemed great, as has the thought of our second child who is due only weeks after the submission of this thesis. I am truly lucky to have had such a happy and wonderful family behind me while I completed this research.

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I have received guidance from Malin Holst and Terry O'Connor, both University of York, on the osteological analysis undertaken. Malin kindly allowed me to sit in on her osteology teaching and gain experience handling and identifying human bones, and was always available to assist with an identification whilst I conducted the analysis on my case study sites. Terry provided extremely useful discussions about taphonomy and identification of animal gnaw marks, as well as explaining the perils of distinguishing human and seal phalanges- thank you Terry!

Thank you to the members of the Bioarchaeology Department, York for their assistance in the ZooMS analysis. Matthew Collins was generous enough to facilitate my training on the ZooMS technique and welcome me into S Block to take part in the vibrant research meetings taking place there. Thank you to Marc Wadsley and Rick Allen who both provided training for me on the ZooMS technique. However a special thank you must go to Sophy Charlton and Harry Robson for conducting the ZooMS labwork on the Havnø samples for me in the end. I was unable to actually conduct the labwork myself, due to being pregnant at the time, so Sophy and Harry made time to process the samples for me. Thank you also to Frido Welker who then gave me some extremely useful guidance when it came to interpreting the spectra for taxa identification in ZooMS.

I would like to thank Tom Booth, University of Sheffield, for his collaboration on the bone diagenesis work. He very kindly agreed to process the Havnø samples and allow me to use the results in this thesis. He also provided very helpful discussion of the results of this analysis.

This research is funded by an AHRC doctoral award and I have also received funding from the University of York, Department of Archaeology Research Grant for research visits and conference attendances.

Finally I would like to say a very big and heartfelt thank you to Nicky Milner, my PhD supervisor. She has not only given me unfailing support and encouragement over the last 5 years of PhD research, but she has been a valued and trusted supervisor to me since I began my undergraduate dissertation in 2005. I can safely say that I would not be where I am today without Nicky's dedication and belief in me. She has not only provided thorough feedback on my academic work but has also never ceased to support my career progression and go the extra mile to help me in any way she can. I hope to one day be able to offer someone else the kind of first class supervision that Nicky has given me.

Author's declaration

I declare that the work presented in this thesis is my own original work, except where stated below. No part of this thesis has been submitted for any other degree. Material on the methodology developed for this study is currently being prepared for publication as follows:

Hellewell, E. and Milner, N. (submitted) "Analyses of the placement of disarticulated human remains in Stone Age shell middens in Europe". In J. Grünberg (ed) *Conference Proceedings, Mesolithic Burials Conference Halle, Germany 2013*.

Labwork conducted for the ZooMS analysis of the Havnø case study was carried out by Sophy Charlton and Harry Robson, University of York and assistance in interpreting the results was provided by Frido Welker. All other work relating to ZooMS analysis is my own. Harry Robson also prepared the samples for the isotope analysis at Havnø and the bone diagenesis work for this case study was undertaken by Tom Booth, University of Sheffield. All other work is my own.

Chapter One: Introduction

1.1 Introduction

Human remains have been found in shell middens all over the world but there has been a surprising lack of research into the reason for this phenomenon. There are many sites which contain inhumations, sometimes in vast quantities, such as the large numbers of sambaquis in Brazil (Wagner et al. 2011, 52) and the famous Mesolithic shell middens of Téviec and Hoëdic (Schulting 1996). However, many shell middens, particularly in northern Europe, contain disarticulated human remains.

Most of the shell middens discussed here date to the Mesolithic and early Neolithic and because of the nature of the sites, made up of mainly food waste, traditional studies of middens have tended to be economic in focus. However, this has led to interpretations that the disarticulated human remains which are present within the midden were discarded as waste, are the remnants of cannibalistic practices (Deacon 1995; Deacon 2001; Rightmire and Deacon 1991; Rightmire and Deacon 2001) or have been overlooked as simply the remnants of disturbed burials (Meiklejohn et al. 2005, 102; Schulting 1996).

Therefore, the potential for studying the burial practices represented by disarticulated human remains found in shell middens has rarely been realised. A notable exception is the study of the human remains in the shell middens on Oronsay, Scotland where it has been demonstrated that, through careful and detailed analysis of very fragmentary human skeletal assemblages, much can be learnt about the biography of the human remains: how they were placed into the midden and to some extent the possible reasons why (Meiklejohn and Denston 1987; Meiklejohn et al. 2005).

In addition, a small number of studies have suggested more complex social and ritual reasons for the placement of human remains into shell middens such as in feasting or as a response to changing relationships with the land and sea at the onset of the Neolithic (Luby and Gruber 1999; Pollard 1996) and recent insights into the dating of human bone in middens in Scotland (Milner and Craig 2009) have further suggested that new study into this area could contribute to the understanding of the Mesolithic-Neolithic transition.

This chapter sets out the aims and objectives of the research. In order to provide a context, the history of shell midden research is summarised before demonstrating the immense scale and diversity of shell middens and the frequency in which human remains are found within them. The important research questions pertaining to human remains in shell middens are summarised and the problems that may be encountered when tackling such questions are addressed. Following this, disarticulated human remains within shell middens are discussed, highlighting the massive potential that these remains hold for enlightening our understanding of secondary burial practices in the past. Finally the sampling of case study sites is outlined.

1.2 Research aims, questions, objectives and approach

The aim of this study is to critically evaluate the evidence for disarticulated human remains in shell middens, using sites in northwest Europe dating to the Late Mesolithic/Early Neolithic as case studies. The research will specifically address the questions:

1) Is it possible to determine whether loose human bones are a result of a disturbed inhumation?
2) To what extent is it possible to reconstruct the processes of deposition?
3) What can disarticulated human remains in shell middens add to the current understanding of Mesolithic/Neolithic transition burial practices?

In order to address the aim and questions the following objectives were set out:

- To examine the variety of ways in which disarticulated human remains are deposited within shell middens.
- To use ethnographic analogy to inform the development of a methodology for studying fragmentary human remains in shell middens through a critical examination of taphonomic processes pertinent to shell midden contexts.
- To evaluate the evidence for ritual treatment of the bones by assessing the types of burials and skeletal elements present, analysing (where possible) sex and age of the remains, and considering evidence for processing of the bone (eg. cut marks) for a number of European case studies.
- To assess the burial practices associated with the inclusion of human bone in Scottish middens from 4,000 BC and to determine whether there are any similarities between the three middens.
- To compare the results from the case studies in order to identify patterns within the context of the late Mesolithic and early Neolithic periods and to examine a potential change in practices at this time in a Danish midden.

A number of methods have been applied in order to conduct this research. Traditional osteological examinations have been carried out for all case studies, but for Havnø in Denmark, due to permissions and access to material, it was possible to also use radiocarbon dating, stable isotope analysis, ZooMS, and bone diagenesis analysis to evaluate the level of understanding of disarticulated human remains that can be achieved.

1.3 Human remains in shell middens- a worldwide phenomenon

1.3.1 An overview of shell midden research

By the end of the 19th Century shell middens had been recognised all over the World (Claassen 1998, 2). Over the last century much research has been conducted on the nature of many of these shell middens and many different approaches have been taken for their investigation.

The Danish kitchen midden commissions, which took place throughout the 19th Century (Milner et al. 2007), were designed to investigate the accumulations of shells found on the coast in order to establish whether they were the result of natural or cultural processes, with the presence of artefacts helping to confirm their cultural origin. The importance of distinguishing cultural shell mounds from natural ones is still pertinent today and by studying the composition of natural mounds essential clues for understanding the cultural middens are gained (Andersen 2007, 32). Since the initial recognition of shell middens as cultural deposits there has been extensive research into the formation processes of shell middens particularly for the Australian shell mounds. The tension between the pressure for urban increase along the coast and the respect for ancient aboriginal sites in Australia was a catalyst for a wealth of investigations in the late 20th century. These focused on how to securely distinguish between a culturally derived shell midden of Aboriginal origin and a natural accumulation (for example Bailey 1993; Bailey et al. 1994; Bonhomme 1999; Stone 1995; Stone 1989).

Another focus of shell midden research has been on economy and subsistence practices. There has been research into the exploitation methods of shellfish, but also fish, and marine mammals which would lead to the accumulation of a midden, demonstrating the specialisation obtained by hunter-gatherer societies in order to capitalise on the marine resources (Andersen 1995; Dupont et al. 2009; Schaller Åhrberg 2007).

Seasonality studies have also dominated shell midden research, focussed on establishing the hunter-gatherer yearly round. Various techniques for establishing seasonality have been used including analysing size of fish otoliths (Mellars et al. 1980), incremental growth line counting in shells (Deith 1983; Koike 1979; Milner 2001) and oxygen isotopes analysis (Culleton et al. 2009).

The dietary contribution of marine foods has also been an important branch of research and used to assess the possible duration of use of shell midden sites by a society, initially being considered by analysis of shellfish yields (Bailey 1975; Erlandson 1988) and later by the assessment of carbon and nitrogen stable isotopes to reconstruct diet (Choy and Richards 2010; Choy and Richards 2009; Fischer et al. 2007; Mannino et al. 2011; Richards and Hedges 1999b).

1.3.2 Nature of human remains in shell middens

Although the build-up of shells into a midden has primarily been understood as an economic activity resulting from the consumption of shellfish, throughout the World these sites also contain evidence of human remains. This phenomenon is not an ambiguity of a particular region but a trait that is shared across continents; from the huge sambaquis of Brazil to the mounds in Japan and the rock shelter accumulations in Scotland. That is not to say that the types of human skeletal remains found in the middens are always the same or that they result from the same practices or beliefs, but it is quite extraordinary that the phenomenon is global and so many societies have chosen to place the remains of their dead in mounds of shells.

Some of the most visually impressive shell mounds are found on the south and south-east coast of Brazil (Wagner et al. 2011, 51) rising up to 30 metres above the surrounding coastal plain (Klokler 2008, 16) (Figure 1). There are over one thousand sambaqui sites known today in Brazil (Gaspar et al. 2008) but many more have been lost through subsequent coastal settlements which destroyed the original mounds. A defining characteristic of the Brazilian shell mounds is the presence of large numbers of human burial remains (Wagner et al. 2011, 52) which dominate the research into these sites.

Figure 1: Sambaqui Figueirinha I (Wikimedia Commons)

One of the most widely studied mounds, Jabuticabeira II, now measures 400m by 250m and up to 9m in height (Okumura and Eggers 2014, 106). Jabuticabeira contains at least 89 individuals (Okumura and Eggers 2014, 106) but could contain as many as 204 individuals (Klokler 2008, 111) buried in individual, double and triple burials which show some tight flexing and possibly some degree of secondary manipulation of the bodies (Klokler 2008, 111-2). The high numbers of burials and their distribution throughout the midden layers has led to the conclusion that this site was built with a primary function as a cemetery site. Based on the ratio of burials to cubic metre excavated, it has been estimated that as many as 40,000 people could have been buried in the Jabuticabeira mound in total (Fish et al. 2000).

Similarly, large numbers of burials have been found in Japanese shell mounds from the Jomon culture. The Yoshigo mound in Tokai contained 304 burials (Kusaka et al. 2008, 173) and there are over one thousand shell middens in Japan, so the total number of burials contained within them could be vast.

In contrast to these huge mounds containing very large numbers of burials there are much smaller examples of burials within shell middens. At Klasies River Mouth Cave 5 (KRM5), South Africa, about 2km from the well-known Klasies River main site, is a Late Pleistocene sand dune capped by a Late Stone Age shell midden (Hall and Binneman 1987). Six articulated burials were found within the late Stone Age cap of the sand dune (Figure 2); five were excavated and one remains in situ. Not only were the burials cut into the shell midden layers but they were all intentionally backfilled with shell midden material which must have been selected from elsewhere in the cave because the deposits surrounding the burials were 'relatively shell free' (Hall and Binneman 1987, 142). In addition to the intentional backfilling of the graves with shell rich material it is clear that shells were an important aspect of burial at this site as a number of shell ornaments were also found as grave goods (Hall and Binneman 1987).

The complexity and diversity of the burials which can be found in shell middens can be demonstrated by the French sites of Téviec and Hoëdic located on small islands off the Atlantic coast of Brittany (Schulting 1996, 335). These middens were excavated in the late 1920's and early 1930's and would have been connected to the mainland at the time of their occupation (Schulting and Richards 2001, 325). Téviec and Hoëdic have broadly contemporary dates of use ranging around 5500-4500cal BC (Schulting and Richards 2001, 324), although Hoëdic does show a larger spread of dates than Téviec (including two outliers). These dates place the burials at Téviec and Hoëdic at the end of the Mesolithic period approaching the advent of the Neolithic.

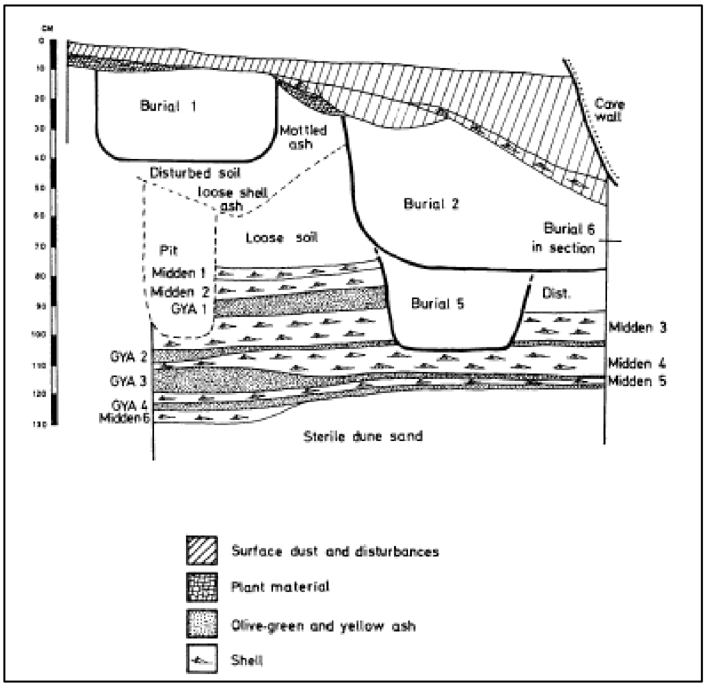


Figure 2: Section of KRM5 showing shell midden strata (From Hall and Binneman 1987, Figure 4)

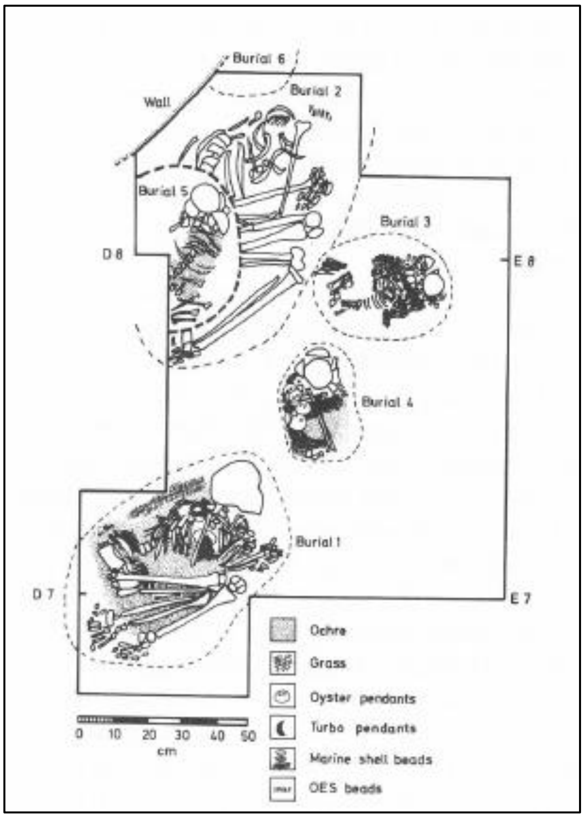


Figure 3: Plan of burials at KRM5 (From Hall and Binneman 1987, Figure 5)

The occupation of both sites is thought to have occurred throughout the year as abundant faunal remains suggest and the possibility of permanent or semi-permanent occupation cannot be ruled out (Schulting 1996, 337). The burials at Téviec were found at the base of the midden within the sterile beach deposits and lower midden material (Figure 4), while at Hoëdic the burials were found in depressions in the bedrock at the base of the midden (Figure 5).

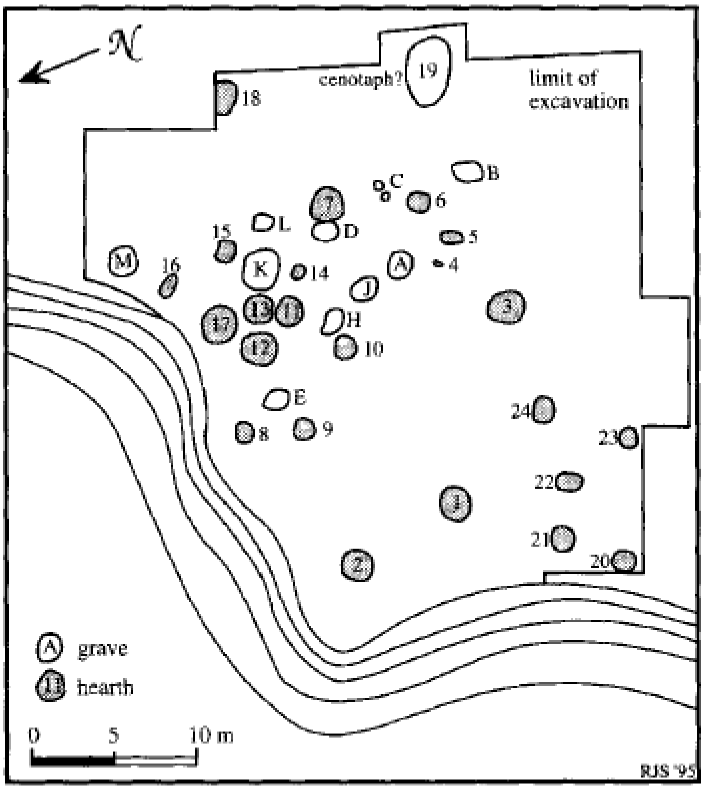


Figure 4: Site plan of Téviec (Schulting 1996, Fiure 2 after Péquart et al. 1937)

Figure 5: The excavation of Hoëdic midden (Schulting and Richards 2001, Figure 2 after Péquart and Péquart 1954)

The graves at Téviec contained a mixture of single individuals and multiple burials; in total there were 10 graves containing 23 individuals including one grave with no body present. At Hoëdic there were nine graves containing 14 individuals and a tenth grave which was smaller and child sized containing no human remains. There were three multiple graves at Hoëdic containing adults with children and articulated skeletons were found in a tightly flexed position (Schulting 1996, 337-9).

Téviec contained substantial stone structures which lined the graves and rose above them up to 0.8m high. As the graves were not found wholly within the midden it is likely that the site was used for burial and then non-burial activities took place which built up the rest of the midden (Schulting 1996, 337). Téviec also contained stone lined hearths which were classified as domestic, feasting or ritual depending on the level of burning and position in the midden (Schulting 1996, 338). Feasting hearths were found nearer larger graves and contain large amounts of calcined bone fragments and charcoal. Smaller ritual hearths were found on top of most graves but the bone within the grave shows no sign of burning in all but one case, indicating that these were not large fires.

The multiple burials in both middens show that the later additions were largely articulated while the earlier burials had been pushed aside and disarticulated to make space for the new (Schulting 1996, 339). There was a passage of around 500 years between interments in grave H at Téviec, although there is some confusion about whether the articulated skeleton is actually earlier than the disarticulated one (Schulting and Richards 2001, 321-2). One burial, skeleton 6 in grave K at Téviec, is unique in that it was the primary interment in the grave but was not pushed aside for later burials. It was contained within a stone lined depression and had its hands crossed on the abdomen. The bones showed signs of *ante-* and *peri-mortem* violence with a healed fracture of the mandible and two microlith projectiles embedded in its spine with no signs of healing (Schulting 1996, 339-40).

Grave goods are found in both middens including pierced periwinkle (*Littorina obtusata)* and cowrie shells (*Trivia europea*), truncated blades and bone pins and red ochre is common to both sites albeit less predominant at Hoëdic (Schulting 1996, 341-5). Structures of red-deer antlers over the heads of individuals are associated with graves in both Téviec and Hoëdic and tend to be accompanied by richer assemblages of artefacts than the other graves (Schulting 1996, 344).

All of the examples of shell middens containing human remains summarised here demonstrate that burials within shell middens can be varied, complex and show clear indications of funerary rituals. The placement of burials within enormous structures like that of Jabuticabeira seems like an intentional act to place the dead in meaningful places within the landscape. The association with shells also seems important, particularly at sites like Klasies River Mouth where the shell midden matrix contained in the burials had been selected over surrounding material which had fewer shells and at Téviec and Hoëdic where numerous perforated shell beads accompany the burials. Structures and hearths within the middens point to ritual and habitational activity which suggest that these sites played an important role in the lives and deaths of their communities.

1.3.3 Key research themes for human remains in shell midden research

The rich record of shell middens containing human remains all over the World has led to a wealth of research into these phenomena. There is a clear focus of the published research on the lifeways of the individuals contained within the middens; from migration and population studies to diet, subsistence and seasonality.

A recent paper presenting a proposed agenda for shell midden research (Balbo et al. 2011) suggested that shell midden burial remains provide huge potential for tracing migratory patterns in human evolution. Morphometric studies combined with culture historical approaches have been used for years in shell midden research to identify potential ethnic groups and propose migration trajectories (Balbo et al. 2011). Evidence of shell middens dating back as far as 200,000 years ago has allowed these sites to be used as a marker for modern human occupation and migration around the globe. For example, the evidence of ochre and engraved bone alongside a shell midden at Blombos Cave, South Africa are taken as indications of modern human behaviour (Henshilwood et al. 2001). The early population of the American continent is often studied using the evidence from shell middens giving support to a coastal migration model (Álvarez et al. 2011, 4). The quantity of marine component in the diet of past populations has been used to distinguish cultural groups along single stretches of coastline (Sealy 2006) and the morphometrics of foot bones has been compared to modern populations (Rightmire et al. 2006).

Study of the diets of people buried within the shell middens has been an extremely hot topic of research in recent years with the use of dietary stable isotopes being applied all over the World. The carbon and nitrogen present in foods consumed are used to maintain and build bones and body tissue (Schulting and Richards 2002, 153) and therefore traces of the stable ^{13}C and ^{15}N isotopes found in bone collagen can be used to assess the marine protein proportions in an individual's diet. A diet consisting of mainly terrestrial protein (C_3 pathway plants or the animals that subsist on these plants) has human bone collagen $\delta^{13}C$ values of around -20 to -21‰, whereas a diet consisting of protein mainly from marine sources would have $\delta^{13}C$ values of around -12‰ (Schulting and Richards 2002, 154). The trophic level of an organism within their ecosystem is represented by the $\delta^{15}N$ values of human collagen isotopes; the higher the value, the higher up the food chain the organism is and a marine diet would be expected to show higher $\delta^{15}N$ values than a terrestrial diet, as the marine ecosystem has many more trophic levels (Richards and Hedges 1999b, 718). Due to the slow nature of turnover of bone collagen the isotope measurements taken from adult human bone collagen represent an average diet makeup over 5-10 years, depending on skeletal element tested (Schulting and Richards 2002, 155).

The location of shell middens either directly on the coast or very close to the ancient coastline makes the human remains contained within them perfect for analysing developments in ancient diet and migration along the coast (Colonese et al. 2011; Fischer et al. 2007; Kusaka et al. 2010). Additionally, these isotopes have been used to interpret differences between and within cultural groups, particularly in Japan where in recent years a number of papers have used isotope analysis to shed light on the relationship between people who had ritual tooth modifications (Kusaka et al. 2008; Kusaka et al. 2010; Kusaka et al. 2011).

Perhaps the most well-known examples of the use of human dietary isotope analysis have been for the extensive debate surrounding the Mesolithic/Neolithic transition in Europe and the degree to which the diet shifted from marine to terrestrial around this time (Milner et al. 2004; Milner et al. 2006; Richards and Hedges 1999a; Richards and Hedges 1999b; Richards and Schulting 2006; Schulting and Richards 2002). Initially, isotope analysis of both Mesolithic and Neolithic human remains pointed to a sharp shift in diet from heavily, if not completely, marine diets in the late Mesolithic populations to an almost entirely terrestrial diet at the beginning of the Neolithic period (Richards and Hedges 1999a; Richards and Hedges 1999b; Schulting and Richards 2002; Schulting and Richards 2001). The argument was that an almost total shift from marine to terrestrial diets occurred at the onset of the Neolithic, at a time when material culture showed an abrupt change with the introduction of monuments and domesticated species. The sudden change in diet pointed to a pronounced change in perception of marine foods with a positive rejection of them occurring from the beginning of the Neolithic despite the continued prowess at seafaring through the collection of marine shells which are present in tombs (Thomas 2003, 69-70). The sudden and complete rejection of marine foods was used to imply that it was a specific cultural aversion rather than gradual integration with an immigrant farming population (Thomas 2003, 70).

In the early part of the 21st century this new evidence provided by isotope analysis on human remains, many of which were recovered from Mesolithic shell middens, had a huge impact on the interpretations of the Mesolithic/Neolithic transition in Britain. However, this position was challenged as an oversimplification of the archaeological evidence for palaeodiet, combining sample bias in selection of human remains used for isotope analysis and problems with the interpretation of the isotope data (Milner et al. 2004). Danish evidence of shell mounds show clear continuity of use from the Mesolithic into the Neolithic, with some such as Norsminde demonstrating that the accumulation of shells in the Neolithic was just as high as during the Mesolithic (Milner et al. 2004, 11). Additionally the presence of faunal remains from wild cattle, red and roe deer and boar in the Mesolithic layers of shell middens on the Jutland peninsula in Denmark suggests that the entirely marine diet might be an oversimplification of the evidence (Milner et al. 2004, 11). It was also suggested that although shell middens are known from the isostatically uplifted shores in Scotland a vast proportion of the prehistoric British coastline has been submerged and the resulting evidence of occupation lost (Milner et al. 2004, 12). The small sample size of human remains tested was also raised as a point of caution by Milner et al. (2004) as the sharp shift papers cited evidence based on 25 Mesolithic and around 30 Neolithic individuals for the whole of Britain and Denmark over a two thousand year period and therefore concluding that a rapid and distinct dietary shift occurred can be seen as a distinct oversimplification of the evidence.

The challenge of the original abrupt dietary shift model by Milner et al. (2004) prompted a response by Richards and Schulting (2006) and a subsequent comment by Milner et al. (2006) but the main impact of this discourse on the use of isotope analysis to interpret diet in the Mesolithic/Neolithic transition in Europe was that it opened up the debate on the topic. What was becoming, in the early 2000's, an accepted interpretation of fast paced, total change with the onset of the Neolithic is now seen as a less clear change around the time of the introduction of farming. This debate shows the important role that human remains in shell middens have played in dietary isotope studies, as primary sources of evidence of human coastal inhabitation.

Another prominent area of research involving human remains from shell middens focuses on the rich evidence of ceremonial and funerary rituals evidenced by the presence of burials within the middens. The fact that inhumations have been placed within shell middens points to intentional use of these sites as important, ritually laden places. In North and South America large shell mounds containing high numbers of burials, hearths and artefacts have been interpreted as places for ritual feasting and remembrance of the dead. One of the pioneering studies interpreting the evidence in this way was Luby and Gruber's study of shell middens in San Francisco Bay in which they sought to move away from the perception of shell mounds as "kitchen middens" primarily serving to inform about subsistence an economic importance and instead consider the cosmological and cultural meaning of such enormous heaps of shell (Luby and Gruber 1999, 98). Shell mounds which were used for several millennia to contain thousands of burials within a mound which was essentially the remains of food debris led these sites to be considered central in mortuary ceremonialism (Luby and Gruber 1999, 100), specifically feasting associated with ancestor worship.

Similarly, freshwater shell middens in Tennessee and Alabama have been described as major ceremonial centres (Claassen 2013, 38) where the monumental size of the shell mounds, use of red ochre and caches of stone tools are in marked contrast to other contemporary burial sites in the region. Claassen also describes a high number of dog burials within the shell middens in this area; at least 230 dog burials in 12 shell middens on the Green River in Kentucky but less than 25 from non-shell-bearing sites of the same period in that region (Claassen 2013, 39). The distinct burial focus of the shell middens described by Claassen are evidence that these sites were ceremonial centres rather than simply occupation hubs or villages where the dead happened to be buried (Claassen 2013, 38-40).

1.3.4 Problems in researching human remains

Whilst the importance of studying human remains in shell middens has clearly been recognised in terms of their contribution to dietary isotope studies, evolutionary mobility and potential evidence of mortuary ceremony there are also limitations to their study. For instance, there is an apparent lack of published evidence for the placement of human remains into the large shell middens in Australia in comparison to the abundance of evidence elsewhere in the world, for example in Brazil (Bailey 2009, 5). Nevertheless it is “common knowledge” (Hope 2011 pers comm.) that there are human remains located in shell middens in Australia. The presence of burials in middens in Aboriginal sites features on the New South Wales, Department for Environment, Climate Change and Water website however, it only mentions the presence of human remains in shell middens and does not go into any explanation of what is found, or where, despite discussing the other types of evidence found in middens (NSW Department of Environment 2008).

The lack of available evidence in Australia is in part because there has been relatively little excavation of shell middens (Bailey 2009, 3; Hiscock and Faulkner 2006, 210) due to the logistical difficulties in digging them but also due to the political sensitivities surrounding the excavation of sites with Aboriginal ties (see for example Bahn and Paterson 1986; Lahn 1996; Langford 1983; Richardson 1989; Hiscock and Faulkner 2006). Any skeletons which have been uncovered due to erosion or development works in New South Wales are reburied under Aboriginal supervision and virtually no new research is carried out (Clark and Hope 1985, 68; Department of Environment Climate Change and Water NSW 2010; Hope 2011 pers comm.).

The very term “middens” could be seen as contentious because it implies that human remains were treated as rubbish by being placed into rubbish mounds. New South Wales’ Code of Practice states that;

> “Archaeological reporting of Aboriginal ancestral remains must be undertaken by, or reviewed by, a specialist physical anthropologist or other suitably qualified person, with the intent of using respectful and appropriate language and treating the ancestral remains as the remains of Aboriginal people rather than as scientific specimens.” (Department of Environment Climate Change and Water NSW 2010, 35)

Therefore any discussion of the placement of human burials into rubbish contexts could be seen as using disrespectful and inappropriate language making the neglect of this topic in the published literature understandable.

That is not to say that there has been no publication of evidence of human remains associated with shell middens. Clark and Hope’s article from 1985 identifies not only the importance of shells as grave goods in Aboriginal burials but also the specific placement of human remains into earth mounds containing shell and shell middens themselves (Clark and Hope 1985). This article is one of the only published references in Australian archaeology which not only recognises but also discusses the presence of human remains in shell middens in Australia.

It called for further discussion of this phenomenon in 1985 recognising that;

> "There is a clear association of mussel shell with burials, in that shell is either deliberately placed in graves , or graves are dug into shell middens…" (Clark and Hope 1985)

However, since this paper was published it has received few citations; two of which are environmental impact reports (Mackenzie Project Environment Group 2003; Dibden 2007), and one is a chapter of an overview book on the archaeology of aboriginal Australia which cites Clark and Hope when summarising the evidence for the Snaggy Bend cemetery (Pardoe 1998, 189) but fails to mention the connection between the burials and shells. This suggests that Clark and Hope's article did not have the impact on future research that they might have intended and perhaps hints at the disinclination to associate burial remains with a midden context. At a site in Lake Victoria, where the conservation of a large number of burials was the main aim of the project, Jeannette Hope recorded over 100 burials before conservation work began but the recordings were never written up (Hope 2011 pers comm.). Clark and Hope's article therefore provides the only real discussion of the evidence present in Australia (Clark and Hope 1985).

Such limitations to archaeological discovery of human remains in shell middens is not isolated to Australia but also exists in America, Canada and New Zealand (Smith 2004) and means that where human remains are discovered, in any indigenous context, they should be treated according to a code of ethics which in most cases compels the cessation of excavation in respect for the connection that the indigenous population have with the ancient remains. Given the quantities of human remains that are often found within shell midden sites it is clear that there is a distinct limitation to the study and understanding of burials where there is indigenous heritage. That is not to say that these codes of conduct are in the wrong, but it is merely important to highlight this as a limiting factor when considering human remains in shell middens.

Another limiting factor encountered in dealing with human remains in shell middens is that often these sites are large with extensive and complicated stratigraphy for which detailed excavation and analysis is time consuming and expensive (Bailey et al. 2013a, 4). Recent studies have demonstrated that careful high resolution excavation of shell midden sites can yield extremely fine grain results, for example in the Yamana settlements in Tierra del Fuego revealed small "packages" of waste limpet shells within mussel middens (Estévez et al. 2013, 112). However, excavation of this resolution is not always possible when rescue excavations are necessary and the particular locations of shell middens on, or close to, the coast mean that many are subject to rescue excavation as the coastline is re-appropriated for modern development or sites are simply lost to erosion or submersion by the sea.

The common archaeological problem of understanding a palimpsest is all too present at shell midden sites, where the nature of these sites means that large volumes of shells are continually brought in, processed and discarded (Rowley-Conwy 2013, 149). When the next volume of shells is brought in the previous dump is likely to be redistributed and flattened to make way for the new shells. Peter Rowley-Conwy gives the example of an active shell midden in Senegal where shells are piled up around the occupation structures used by the inhabitants (Figure 6). He suggests that due to the volumes at play the structures would have to be relocated frequently and the posts reused, minimising the likelihood of decay in situ and eradicating any trace of post holes and the floor as the shells moved and settled (Rowley-Conwy 2013, 149).

Figure 6: Modern Saloum Delta shell midden, Senegal showing shell masses accumulating around occupation structures (after Rowley-Conwy 2013, Figure 12.8)

1.4 Disarticulated human remains in shell middens, an unexplored phenomenon

Despite the rich body of research into shell middens which focus on their formation processes, the diet and subsistence of the people who lived and were buried in them, as well as consideration of the burials, mortuary rituals and possible feasting ceremonies which took place on these middens, there has been very little attempt to explain and interpret the presence of disarticulated human remains within shell mounds.

Ethnographic examples highlight that the integrity and completeness of the skeleton is often not important thus resulting in disarticulated remains. The ritual significance of disarticulated remains in Neolithic burial practices has been recognised for some time (for example Parker-Pearson 1999;

Parker-Pearson 2000; Parker-Pearson 2005; Whitley 2002) and is beginning to be appreciated in the Mesolithic period (Cauwe 2001; Conneller 2006; Gray Jones 2011; Green 2006; King 2003; Meiklejohn et al. 2005). Despite this knowledge of secondary funerary treatments resulting in disarticulated remains in ethnography, and their application in Neolithic and increasingly Mesolithic studies, there is still a reluctance to apply these ideas to the disarticulated remains in shell middens.

The presence of disarticulated, fragmentary or commingled bone within shell middens is not in question; studies often mention the presence of isolated human remains but offer little in the way of explanation of their incorporation into the site. For example "many disarticulated human teeth and small pieces of bone" (Schwardon 2013, 51) were found in the Youman's mound complex in Florida but the author provides no further comment except to say that upon this discovery excavation stopped according to the Native American Graves Protection and Repatriation Act (Schwardon 2013, 51). Often where there is rich evidence of articulated inhumation burials alongside evidence of disarticulated remains the focus is primarily on the inhumations. In the studies of Brazilian sambaquis like Jabuticabeira II there is sometimes mention of possible secondary burial practices but little further analysis on the possibility and nature of this phenomenon (Klokler 2008, 114).

The seeming lack of importance placed on disarticulated human remains in cases such as these fails to recognise the fact that these are remains of human beings which are unlikely to have simply ended up in the shell middens with no agency by fellow humans. The human reaction to death as meaningful and expressive (Huntington and Medcalf 1979 in Pettitt 2011, 2) is considered a defining and unique aspect of humanity which has been present since Neanderthals and early *Homo sapiens* began to deliberately create places to dispose of and commemorate their dead (Pettitt 2011, 263). Given the recognised meaning which humans have placed on death and burial (or mortuary process) since the mid Upper Palaeolithic it seems simplistic and careless to present interpretations of disarticulated remains without considering the processes which led to their incorporation into the midden.

In some cases there have been attempts to explain the presence of fragmentary and disarticulated remains within shell middens. Particularly because of the food waste connotation of kitchen middens there has often been a tendency to attribute commingled human remains found within the shells likewise as food remains. For example the Bindjai Tamiang midden, Indonesia, contained a number of disarticulated human remains, specifically; a cranium, three other skull fragments, a maxilla with 6 teeth, and 30 limb bones and other fragments (Schürmann 1931 in van Heekeren 1972, 88). Many of the long bones were split which, combined with the disarticulated state of the remains, was interpreted as being the result of cannibalistic activity at the site (van Heekeren 1972, 88). The account of the stratigraphy given by van Heekeren seems to show that most of the human bone was found in ashy layers containing red ochre, which alternated with shell rich strata suggesting there was some element of occupation and possibly ritual activity at the site at the time that the human remains were deposited (van Heekeren 1972, 89).

Similarly the presence of disarticulated human remains in the Klasies River Main Site shell midden has also been interpreted as the result of cannibalistic activity. The oldest level at Klasies River Main Site contains a "shell-rich midden heap" (Deacon 1995, 125) within which two maxillary fragments from two different individuals have been recovered dating to approximately 110ka (Deacon 1995, 125; Deacon 2001, 7). Directly above the oldest layer is another which also contains "shell-rich middens" (Deacon 1995; Deacon 2001) as well as many human remains, the majority of which are fragmentary in nature, and cranial remains with only a few post-cranial bones having been recovered (Deacon 1995; Deacon 2001; Rightmire and Deacon 1991; Rightmire and Deacon 2001; Rightmire et al. 2006; Singer and Wymer 1982). Due to the fragmentary nature of the human remains, the presence of cutmarks, breaking and burning of bone, as well as the fact that they were found in shell midden layers, which are interpreted as food debris, there has been repeated interpretation of the human remains as evidence of cannibalism at Klasies River main site (Deacon 1995; Deacon 2001; Rightmire and Deacon 1991; Rightmire and Deacon 2001). This interpretation is also present in popular summaries of the findings at Klasies River sites, for example this online appraisal of the site:

> "Fossil human remains were found in several layers of the Klasies River occupations, fire-blackened fragments of skulls and other bones showing cut marks. While this alone would not convince researchers that cannibalism had taken place, the pieces were mixed with the rubble of kitchen debris--thrown out with the shells and bones of the remainder of the meal." (Hirst n.d.)

Although one paper does discuss the relationship between cannibalistic practices which process the human body and the butchery practices which process animals, suggesting that the fragmentation of both shows similar perceptions of humans and animals (Deacon 1995, 127), there is little other discussion which considers alternative explanations of the evidence other than cannibalistic behaviour. The importance of further study of the human remains from a taphonomic perspective is noted by Deacon (2001, 10) which he states is a "current project", although it has not at this stage been possible to identify any publications resulting from this work. He concludes that the human remains are not the result of traditional burial practices but that there is likely to be a ritual element to the placement of the remains in the midden (Deacon 2001, 10).

The lack of focus into the presence of disarticulated human remains in shell middens is equally present in Europe as in the rest of the World. It has been widely accepted for decades that Neolithic responses to death centre on the disarticulation of the body and curation and manipulation of the bones (for example Barnatt and Edmonds 2002; Bender 1978; Edmonds 1999; Parker-Pearson 2000; Thomas 1991; Whitley 2002) but until very recently there was a reluctance to recognise that any intentional human action was associated with disarticulated remains in the European Mesolithic at all, never mind shell middens (Green 2006). Over the last decade Mesolithic research has begun to focus on the fragmentary and disarticulated human remains to show that they are representative of intentional burial treatment of the dead (Cauwe 2001; Conneller 2006; Conneller 2009; Gray Jones 2011; Hellewell and Milner 2011).

Despite the new recognition of the variety of mortuary practices demonstrated in the Mesolithic archaeological record in Europe, still little emphasis has been placed on disarticulated remains in shell midden contexts. The most prominent and pioneering paper on this topic presents the evidence from Cnoc Coig, Oronsay, Scotland with detailed spatial analysis of the remains showing a striking preponderance of hand and foot bones which seem to be intentionally placed in the midden (Meiklejohn et al. 2005). This paper clearly demonstrates the potential of detailed analysis into disarticulated human remains in shell middens but there has been a lack of comparable studies since. Other studies which do refer to disarticulated human remains in shell middens such as Schulting's work on Téviec and Hoëdic merely confine the commingled bone to remnants of inhumation burials which have been disturbed during subsequent interments (Schulting 1996).

It is clear that vast quantities of human remains have been discovered in shell middens across the World. They are subject to an array of fascinating research which deals with the lives of the people buried in the middens and the possible uses of the sites in which the bodies were placed but which too often neglects the processes by which the human remains might have been incorporated into the middens. It is these processes of burial and funerary rites which directly reflect the actions and intentions of the people using the middens as burial places.

1.5 Continuity and change at the Mesolithic/Neolithic transition

Traditionally, the transition between the Mesolithic and Neolithic periods in the British Isles has been identified as occurring around 4,000cal BC and is seen as a time when a considerable change took place; with the introduction of domesticates and grain, polished stone tools, monumental architecture and pottery (Hellewell and Milner 2011). Not only has the transition been seen as a time of great change but this change was thought to have occurred relatively quickly (Richards et al. 2003) notably demonstrated by a seemingly sharp shift in diet from the marine based

Mesolithic hunter gatherer fishers to terrestrial Neolithic agriculturalists (Richards and Hedges 1999a; Richards and Hedges 1999b; Richards et al. 2003; Schulting and Richards 2002; Schulting and Richards 2001).

However, these assertions about the speed and wholesale nature of the change have begun to be brought under question by developments in Bayesian approaches to radiocarbon calibration providing a more nuanced picture of the introduction of monuments (Bayliss et al. 2007; Whittle et al. 2007a). Additionally, recent debate has focused on whether the changes that occurred were the result of indigenous people adopting new practices (Thomas 2007) or movement of people from the continent (Sheridan 2007). The result is that further studies have now questioned whether the transition was actually far more messy and complex than previously thought (Cooney 2007).

The understanding of burial practices around this time is no less complicated than the economic changes that took place, with growing evidence for continuity as well as change at this time. Studies have shown that Mesolithic burial practices are likely to have involved disarticulated human remains (Conneller 2006; Gray Jones 2011), a rite which has usually been attributed to Neolithic innovation (Parker-Pearson 1999, 52). There has also been shown to be continuity in use of places for the dead in both the Mesolithic and Neolithic, notably caves, as well as innovative expressions of burial customs in the use of monuments in the Neolithic (Hellewell and Milner 2011).

Shell midden sites have been suggested as a possible key in the understanding of burial practices around the transition in western Scotland (Milner and Craig 2009). Reassessment of the radiocarbon dates taken on these middens led Milner and Craig to conclude that there is some continuity in use of shell midden sites post 4,000 BC but that it appears that a new practice of placing disarticulated remains into these middens appears to emerge around this time (Milner and Craig 2009, 179). Human remains from Cnoc Coig shell midden, Oronsay have traditionally been seen as securely Mesolithic in date, given their placement in a Mesolithic shell midden and their distinctive marine isotope signatures (Richards and Hedges 1999a). However Sheridan has suggested that the very first evidence of the Neolithic in this area might have occurred earlier at around 4,200 BC (Sheridan 2007) and new calibrations on the dates of the bones from Cnoc Coig suggest that they are much closer to 4,000 BC than previously thought (Milner and Craig 2009, 178-9).

A number of shell midden sites on the west coast of Scotland, three of which are examined as case studies in this thesis, have evidence for disarticulated remains being incorporated into earlier shell middens at around 4,000 BC or later, the time of the Mesolithic/Neolithic transition (Milner and Craig 2009). This is something for which there is no evidence during the British Mesolithic. It is not clear whether the people doing this were indigenous hunter gatherers using the middens for burial in a way that had not been seen before in order to express a link to ancestral sites or if they were copying new practices of placing disarticulated remains into significant places on the landscape, or even if they were migrating farmers introducing a new form of burial practice.

Current debate on the Mesolithic/Neolithic transition suggests that the change was not as quick or all-encompassing as previously thought and that there is likely to have been elements of continuity from Mesolithic hunter gatherers to Neolithic farmers. It has also been highlighted that the shell middens spanning this transition, with evidence of an emerging burial practice occurring post 4,000 BC, are well placed to investigate this continuity and change.

1.6 Choice of case study sites

A series of case studies is presented in this thesis to address the neglect of consideration of disarticulated human remains within shell middens. These case studies examine the human remains in order to understand more about how they came to be incorporated into the midden and whether intentional funerary practices or non-human taphonomic factors influenced their presence.

The selection of sites to form case studies for this research has been largely made based on where it was possible to gain access to the human remains collections. There are always sensitivities when dealing with human remains and access to them is often closely controlled. The fact that the analysis for this research was largely non-destructive, apart from some of the scientific analyses employed at Havnø, enabled access to be secured to some previously unstudied collections, such as the the new human remains from Cnoc Coig, Oronsay.

Three of the four case studies are from Scottish midden sites which span the Mesolithic/Neolithic transition: Carding Mill Bay, Cnoc Coig, An Corran. These sites were chosen in order to further investigate the degree of change and continuity demonstrated by these middens at the time of the transition as well as to provide some comparison within this study region and also because of accessibility of material. Although osteological reports had been written for Carding Mill Bay and An Corran, these were not detailed and from the data it was not possible to address the questions set out above: therefore further, more in depth analysis was required. For Cnoc Coig, an opportunity arose to examine material never studied before. Cnoc Coig is the only one of the three which contains human remains dated to the Mesolithic period (although the dates are right at the transition), whilst Carding Mill Bay and An Corran both contain Neolithic human remains which have been inserted into a Mesolithic midden. Choosing to analyse this selection of sites provides an opportunity to consider both the nature of the transition from the Mesolithic to the

Neolithic in Scotland as well as the relationship between shells, and shell midden sites, and funerary behaviour at this time.

In addition, the Danish shell midden (Havnø) which spans the Late Mesolithic and Early Neolithic was selected for analysis. Although a number of Danish shell middens contain human bone, there is little published data and access for study can be difficult. Therefore, it was deemed necessary to work on a site currently being excavated which had the advantage of providing good spatial data and the necessary permissions to carry out scientific analyses. It is also considered a complimentary study of a midden which spans the Mesolithic/Neolithic transition. Not only that but the generous access to the human remains from this site, provided by Søren Andersen, allowed a pioneering suite of techniques to be applied to these remains. The detailed excavation records available for Havnø also enabled a much more fine scale analysis of the spatial distribution of the human remains than is possible with rescue excavations such as those at An Corran and Carding Mill Bay.

Finally, two other case studies were used to test taphonomic theories. The first was the site of Janaba Bay East, Farasan Islands, Saudi Arabia which contained an inhumation burial which was badly preserved. The second was a cist inhumation burial at Carding Mill Bay which had also been disturbed. Both of these case studies provided primary evidence from burials which were highly likely to have been articulated inhumations at the time of burial but which did not contain the remains of a full skeleton at the time of archaeological excavation. They therefore provide suitable test cases to examine the pattern of preservation expected of inhumation burials at shell midden sites.

1.7 Structure of this study

This chapter has presented an illustrative discussion on the variety of ways in which human remains are deposited within shell middens, including focussing on the inequity of consideration of disarticulated remains and articulated burials that exists in the literature.

Chapter 2 goes on to outline the methods which have been applied in this study to examine the human remains found within the shell middens. Traditional osteological methods of analysis have been combined with common zooarchaeological techniques in order to provide a new, more informative and thorough means of considering disarticulated and fragmentary assemblages of human bone.

Profiles of expected burial remains in a series of potential taphonomical scenarios are presented in Chapter 3 which will be used to inform the analysis and discussion of the following case studies. These burial profiles are created through critical examination of taphonomic processes which are pertinent in shell midden contexts combined with ethnographic examples of treatment of the dead.

A series of European case studies are presented in Chapters 4-7 which apply the methods and bone profiles to evaluate the evidence for ritual treatment of the bones. These case studies combine analysis of age, sex, MNI with spatial distribution and skeletal element distribution in order to challenge a common assumption that fragmentary remains are merely the result of disturbed burials. Chapter 7 presents evidence from Havnø shell midden in Denmark where it has been possible to apply dietary isotope analysis and cutting edge bone diagenesis analysis to demonstrate the further potential of even fragmentary remains to refine the MNI at the site and develop interpretations of the funerary practices which were employed at the site.

Chapter 8 brings together all of the analysis from the case studies to examine the similarities and differences between the profiles of skeletal remains contained within the shell midden sites. It also considers the methodological challenges in dealing with disarticulated remains which have a bearing on the conclusions that can be drawn about burial practices. Finally, the contribution that disarticulated remains in shell middens can have on the discourse of Mesolithic/Neolithic transition burial practices are assessed in order to add to the developing picture of mortuary complexity and variety at this time in prehistory.

The potential for future research into disarticulated human remains in shell middens is examined in Chapter 9 and finally a model for future work on these types of remains is suggested.

Chapter 2: Osteological Methodology

2.1 Introduction

In order to investigate the nature of placement of human remains into shell middens a series of case studies was considered. Each of these case studies involved primary, largely non-destructive, analysis of the human remains including photographic recording, osteological analysis of age and sex of the bones and close examination of the remains to identify any taphonomic alterations.

In the main, human remains from archaeological sites are found in graves, and are usually articulated. In many European shell midden contexts, including the ones studied as part of this research, human remains are found in a disarticulated state and therefore a specialised recording procedure was needed.

Guidance on the recording of commingled human remains (Buikstra and Ubelaker 1994; McKinley 2004b) suggests grouping an assemblage into component skeletal elements to aid analysis of the assemblage as a whole. This grouping prior to osteological assessment of the remains is suited to large commingled human remain assemblages for example those found in mass graves or highly disturbed grave-yards. However for the purposes of this study such grouping was not applicable due to the remains being generally small in number and easily classified as individual specimens.

The recording procedure applied here was designed specifically for the purpose of this study and adapted from common osteological recording procedures (Buikstra and Ubelaker 1994, 9). The decision was taken to record and assess every disarticulated bone individually to allow detailed analysis of each skeletal specimen.

This chapter sets out the methodologies used for examining the skeletal record. First, the ways in which the human remains are recorded are set out; second it details how the skeletal element frequencies are then calculated, and third it explains how dates are used within this thesis.

2.2 Recording of human remains

2.2.1 Introduction

Every bone from each case study midden has been analysed in detail following standard osteological recording techniques and which are described in this section. In addition, every bone analysed has been photographed in order to provide a comprehensive visual record and photographic archive of the remains. Each bone has been photographed from a variety of anatomical positions and specific photos taken to highlight any notable features of the bones, for example pathologies, evidence of burning or cutmarks.

2.2.2 Taxa identification

In the case of articulated human remains they are usually identified as human during excavation when the burial cut and articulated remains are observed. Articulated inhumations are normally easily identifiable as human in the field, and certain recognisable disarticulated elements can also be readily identified as human, for example the skull or long bones. Where bones are completely disarticulated and fragmentary it can be more of a challenge for a non-human bone specialist to positively identify the bones as human. Where bones are not identified as human on site the post-excavation analysis will generally pick them out, where a specialist in human and/or animal bone will recognise the distinctive morphology of the bone and has the benefit of comparative skeletal material to aid identification. At this stage bone is categorised according to taxa and generally an unidentified bone grouping remains where bones are too fragmentary to contain diagnostic morphology which allows confident identification.

The human remains assemblages dealt with in this study had already been identified and grouped accordingly but where possible other unidentified bone was also looked at in order to assess where there might be further identifiable human bone. Generally, comparative skeletal material was used for identifying human bone in this study, including use of a comparative manual (White and Folkens 2005), but for the case study of Havnø the method of Zooarchaeology by Mass Spectrometry (ZooMS) was applied. ZooMS is a technique pioneered at the University of York (Buckley et al. 2009; Buckley et al. 2010; Collins et al. 2010), which uses the premise that peptides in bone collagen can act as a “fingerprint” unique to genus, and that these “fingerprints” can then be used to identify the genus or species of an unidentified piece of bone (Collins et al. 2010).

This technique has great potential to identify small fragments of human remains from the large collections of unidentified bone generated through excavation of shell middens. ZooMS analysis was conducted on a sample from the Havnø case study and was carried out by colleagues in the BioArCh department at the University of York according to the destructive acid demineralisation method (see Welker et al. 2015, 281 for details). Taxa identification focussed on the identification of human peptide markers only, specifically peptide marker B with a mass of 1477.7 m/z.

The advantage of this technique is that if small human specimens are identified in this way the bone fragments can then be used for further scientific analysis, such as dietary isotope or DNA analyses or C14 dating, without having to carry out destructive sampling on more complete remains. Although the contemporaneity of the small fragments identified by ZooMS with the larger traditionally identified human remains is hard to demonstrate, the technique is still in its infancy and new minimally destructive and non-destructive methods are now being developed (von Holstein et al. 2014).

2.2.3 Terminology

It is important to clarify the terminology applied to the human bones recorded as part of this study. Lyman (1994) suggested a distinction between the use of the term skeletal *element* and *specimen* in his work on vertebrate taphonomy in order to avoid confusion over the discussion of complete bones or fragments of bones in an assemblage. He defined a skeletal *element* as "a discrete, natural anatomical unit of a skeleton" (Lyman 1994, 100) or in other words a whole bone or tooth. In contrast a skeletal *specimen* was defined as "an archaeologically discrete phenomenological unit" (Lyman 1994, 100) meaning any whole bone or tooth, or fragment of bone or tooth. So an ulna, for example, could be referred to as a skeletal element, because it is a whole bone, or a skeletal specimen, but the distal third of an ulna would only be referred to as a skeletal specimen because it is a fragment of the skeletal element of the ulna.

It was particularly important to apply this terminology for the purposes of this study as the human remains were largely in a fragmentary state. Discussion of elements without being specific about what was meant by this could give a false impression that whole skeletal elements were present when in fact they were only represented by a fragment of an element.

2.2.4 Recording

During the recording process each skeletal specimen analysed was assigned to a particular area of the body. By dividing the skeletal specimens into body parts in this way it is possible to distinguish patterns in the placement of human remains more clearly. The terminology applied in this study is based on that suggested in Duday's appendix (2009) with the addition of an "extremities" category (Table 1).

	Area of body	Skeletal elements included	Number of bones in each area of body
1	Skull	Cranium	3
		Mandible	
		Hyoid	
2	Vertebral Column	Cervical Vertebrae (7)	26
		Thoracic Vertebrae (12)	
		Lumbar Vertebrae (5)	
		Sacrum	
		Coccyx	
3	Rib Cage	Ribs	25
		Sternum	
4	Upper Limbs	Scapula	10
		Humerus	
		Radius	
		Ulna	
5	Lower Limbs	Pelvis	10
		Femur	
		Patella	
		Tibia	
		Fibula	
6	Extremities	Carpals	104
		Metacarpals	
		Tarsals	
		Metatarsals	
		Sesamoids	
		Phalanges	

Table 1: Terminology applied to areas of skeleton. (After Duday, 2009)

Specialised recording sheets were designed to ensure that a standard set of information, which is tied into the aims of this research, was recorded for each specimen. The recording sheets have been designed to include all basic osteological information required by the best practice guidance by the IFA (Brickley and McKinley 2004) and "The Standards for Data Collection from Human Skeletal Remains" (Buikstra and Ubelaker 1994) in addition to those taphonomical observations critical to this research. The general recording sheet for each disarticulated specimen includes space for recording:

- details of the site in which the specimen was found, its curation and the date the analysis was carried out
- bone, side, segment, number of fragments, completeness and preservation
- any associated human remains and artefacts, where noted
- position of specimen in midden and orientation, if known
- details of pathology if present
- record of non-metric traits present (the non-metric traits considered are based on those stated by McKinley (2004b) and Buikstra and Ubelaker (1994))
- age, sex and stature estimations
- measurements of the bone

A copy of the recording sheet used for commingled assemblages can be found in Appendix 1.

2.2.5 Ageing

Ageing of skeletal remains always involves an estimation of the age at death of an individual because it is based on three possible areas of inaccuracy. Firstly the fact that age estimation is based on assigning an arbitrary age to the continuum of an individual's growth (White and Folkens 2005, 363). Every individual grows and matures at a unique rate, although following a general pattern. Therefore individuals of the same calendar age, even within the same population, can vary a great deal in their degree of skeletal development (Cox 2006; Roberts 2009; White and Folkens 2005). This degree of variation naturally leads to imprecision in ageing of skeletal remains and so generally an age-range is provided for a specimen, rather than a specific age. The age ranges quoted are more refined for sub-adults as younger skeletons are still developing and thus display a greater range of age-related attributes, such as epiphyseal fusion and dental eruption. Age range terminology used in this study is based on the categories defined by Buikstra and Ubelaker (1994) (Table 2).

The second area of inaccuracy in ageing skeletal remains occurs because of the investigator's skill in estimating age based on objective observations of the bones (White and Folkens 2005). This imprecision can be reduced by the use of standard categorization of observed traits, and such standards have been applied in this study based on those set out in Buikstra and Ubelaker (1994) and O'Connell (2004) (Table 3).

Age Categories:	
Fetus:	up to 40 weeks *in utero*
Neonate:	around the time of birth
Infant:	following birth to 1 year
Juvenile:	1-12 years
Adolescent:	13-17 years
Young Adult:	18-25 years
Young Middle Adult:	26-35 years
Old Middle Adult:	36-45 years
Mature Adult:	46+ years
Adult:	too incomplete to determine but over the age of 18

Table 2: Age category terminology. (Based on Buikstra and Ubelaker 1994)

Finally, the third reason why ageing of skeletal remains can be inaccurate is that the comparable data, used to develop the ageing techniques, were largely developed using archaeological skeletons of unknown age (Cox 2006). Additionally, many modern samples exhibit biases in the socio-economic backgrounds which could also skew the age assessments (Cox 2006). This third area of inaccuracy is unfortunately largely unavoidable but the generally accepted suite of techniques, as set out in published guidelines (Brickley and McKinley 2004; Buikstra and Ubelaker 1994), which are widely used to estimate the age at death of archaeological individuals, will be applied here.

It has been argued that to increase the accuracy and precision of ageing archaeological skeletal specimens a multifactorial age estimation is preferred (White and Folkens 2005). This is not universally accepted by osteological specialists (Cox 2006) as some age estimation techniques have been shown to be more precise and accurate than others. However, the guidance for best practice (Brickley and McKinley 2004; Buikstra and Ubelaker 1994), which has been used as a basis for the development of the methodology applied in this study, states that all available methods for ageing should be considered. The advantages of applying a multifactorial approach are that inaccuracies of individual techniques are overridden because a second or third method is being applied and can correct for a mis-estimation in one.

In this study, all available age diagnostic skeletal specimens present were used to provide an age estimation. Where disarticulated bone was encountered, each specimen was assessed for ageing potential and if appropriate the standardised techniques were applied (Table 3). In some cases it was not possible to precisely age the specimen and it was therefore distinguished, where possible, as adult or non-adult.

Part of skeleton	Ageing method	Scoring system(s)	Reference
Pelvis	Pubic symphysis	Todd; Suchey-Brooks	(Buikstra and Ubelaker 1994, 22-24)
	Auricular surface	Meindl and Lovejoy	(Buikstra and Ubelaker 1994, 24-32)
Skull	Cranial suture fusion	Meindl and Lovejoy	(Buikstra and Ubelaker 1994, 32-38)
	Dental wear	Brothwell; Lovejoy	(Brothwell 1981; White and Folkens 2005, 369)
	Dental eruption	Ubelaker	(Buikstra and Ubelaker 1994, 51)
Post-Cranial Skeleton	Skeletal epiphysis fusion	Buikstra and Ubelaker	(Baker et al. 2005, Figure 9.9 ; Buikstra and Ubelaker 1994, 40-43)

Table 3: Techniques and scoring systems applied for ageing skeletal remains. Where more than one scoring system is stated, all are applied.

2.2.6 Sexing

As with ageing skeletal specimens, there are inaccuracies involved in sexing human skeletal remains. The most obvious one is observer error, as the techniques applied require the investigator to estimate the extent of a certain attribute in order to determine if it is male or female. Sexing techniques are based on the differences in skeletal morphology between males and females which tend to develop during puberty (Mays and Cox 2006), hence sexing skeletal remains of non-adults is not sufficiently accurate to be a reliable approach and will not be used in this study.

Pelvic sex determination uses assessment of the sciatic notch, subpubic angle, subpubic concavity, ishiopubic ramus, ventral arc and preauricular sulcus (Buikstra and Ubelaker 1994, 16-19). Cranial sex determination is based upon observation of the mental eminence, nuchal crest, mastoid process, supra-orbital ridge and orbital rims (Buikstra and Ubelaker 1994, 19-21). Additionally, the morphology of the mandible can also be assessed and it is recommend that the recording of overall size, width of ascending ramus, flaring of gonial angle and shape of chin (Brickley 2004) rather than simply the mental eminence suggested by Buikstra and Ubelaker (1994).

Measurements of skeletal specimens also provide a means to sex them where diagnostic pelvic and cranial specimens are not present (Bass 2005) (Table 4). The measurements are understandably more open to inaccuracies as they are dependent on the morphology of the reference sample (Brickley 2004).

Measurements:	
Clavicle length	**F** <138mm; **M** >150mm
Scapula glenoid width	**F** <26mm; **M** >29mm
Humeral head width	**F** <43mm; **M** >47mm
Radial head width	**F** <21mm; **M** >23mm
Femoral head width	**F** <43mm; **M** >48mm
Femoral distal epiphysis width	**F** <74mm; **M** >76mm

Table 4: Skeletal Measurements used to determine sex

Sex determination applied in this study is primarily reliant on the pelvis and skull according to best practice recommended in guidance on recording human remains (Brickley and McKinley 2004; Buikstra and Ubelaker 1994), although some skeletal measurements (Bass 2005) have also been considered where appropriate. Where fragmentary remains have been analysed, sex was only assigned where a diagnostic part of the skeleton was present. It was recorded as "Male", "?Male", "Ambiguous", "?Female" and "Female" (Buikstra and Ubelaker 1994). In all other cases where sex could not be determined it was recorded as "Unknown".

2.2.7 Stature estimation and osteological measurements

Where complete long bones with no breaks in the shafts are present, an assessment of stature can be made. However any broken long bones should not be considered for stature estimation, including those that have been glued back together as gluing can distort the measurement (Holst 2011, pers comm.). There were no intact long bones present in the assemblages studied as part of this study and therefore it has not been possible to provide stature estimations.

Where other, non-stature relating, elements were intact, measurements have been recorded according to those recommended in Buikstra and Ubelaker (1994) where the part of the specimen to be measured is complete. Otherwise, where the skeletal specimen was damaged the maximum length and width of the fragment was measured in order to allow an assessment of the degree of fragmentation of the assemblage.

2.2.8 Taphonomy

Every bone has been examined macroscopically and a hand-held magnifying glass used to check for any small modifications of the bone and assess whether they were cultural or taphonomic. Any observation of burning, weathering, cutmarks, animal gnawing, root/fungal activity, peri-mortem breakage and other cultural modification were recorded for each bone specimen.

2.2.8.1 Burning

Evidence for burning of the bone has been recorded in line with the standards set out by Buikstra and Ubelaker (1994, 105) which includes noting where on the bone the burning occurs and the percentage of bone which has been affected by burning. Also the colour of the burnt bone has been recorded using the Munsell Soil Colour Chart (Munsell 2000) and the colour of normal bone recorded as a comparison. Details of the surface texture of the bone have been described and any evidence of warping noted. Photographs of the burning have also been taken.

Lyman (1994, 386) provided a summary of the changes of bone subject to heating which can be applied to the information recorded as part of this study in order to attempt to understand the human actions which led to the human bones being burnt (Figure 7).

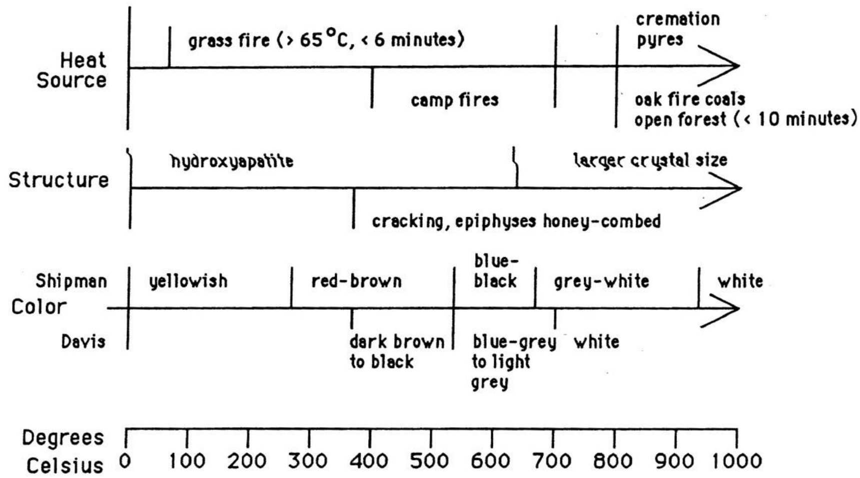


Figure 7: Changes to bone subject to heating (Lyman 1994, Figure 9.9)

2.2.8.2 Weathering

The presence, location and degree of weathering present on the bone has been recorded following the recommendations in best practice guidance (Buikstra and Ubelaker 1994, 98). A description of the weathering observed has also been recorded and photographs of the affected areas have been taken. The degrees of weathering, as set out by Behrensmeyer (1978) and modified by Buikstra and Ubelaker (1994) are as follows:

Stage 0: Bone surface shows no sign of cracking or flaking due to weathering

Stage 1: Bone shows cracking, normally parallel to the fiber structure (eg. longitudinal in long bones). Articular surfaces may show mosaic cracking.

Stage 2: Outermost concentric thin layers of bone show flaking, usually associated with cracks, in that the bone edges along the cracks tend to separate and flake first. Long thin flakes, with one or more sides still attached to the bone, are common in the initial part of Stage 2. Deeper and more extensive flaking follows, until most of the outermost bone is gone. Crack edges are usually angular in cross section.

Stage 3: Bone surface is characterized by patches of rough, homogenously weathered compact bone, resulting in fibrous texture. In these patches, all the external, concentric layers of the bone have been removed. Gradually the patches extend to cover the entire bone surface. Weathering does not penetrate deeper than 1.0-1.5mm at this stage and bone fibres are still firmly attached to each other. Crack edges usually are rounded in cross section.

Stage 4: The bone surface is coarsely fibrous and rough in texture; large and small splinters occur and may be loose enough to fall away from the bone if it is moved. Weathering penetrates into inner cavities. Cracks are open and have splintered or rounded edges.

Stage 5: Bone is falling apart, with large splinters. Bone easily broken by moving. Original bone shape may be difficult to determine. Cancellous bone usually exposed, when present, and may outlast all traces of the former more compact, outer parts of the bones.

2.2.8.3 Cutmarks

Recording of cutmarks observed on the bone noted the location, number of cuts, range and average lengths of cuts, a description of the cutmarks and photographs of them (McKinley 2004b). In addition, a classification of the marks as chop marks, cut marks or light defleshing marks (McKinley 2004b) has been recorded.

2.2.8.4 Gnawing

Best practice guidance suggests recording the location of any gnawing evidence, the number of paired grooves or incisions and a description of the marks observed (McKinley 2004b, 15). Where possible gnaw marks were present they were recorded following these guidelines.

2.2.8.5 Root/fungal activity

All bone specimens were assessed for observable obvious root marks or any fungal activity as this is recommended in guidance for recording commingled remains (McKinley 2004b, 15). No evidence of clear root or fungal activity was observed on the specimens which formed part of this research.

2.2.8.6 Peri-mortem breakage

Any evidence of peri-mortem breakage of the bone has been recorded as suggested by McKinley (2004b, 15). Peri-mortem breakages on "green bone", or bone which retains some organic component, are indicated by straight sharp linear edges (White and Folkens 2005, 51) and longitudinal or spiral in shape (Figure 8). In contrast breakages which occurred on "dry" bone long after death have a rougher and more jagged fractures (White and Folkens 2005, 51) (Figure 8). The colour of the break can also indicate whether the fracture occurred peri-mortem or post mortem; a fracture the same colour as the rest of the bone is likely to have occurred by the time that the bone was deposited in the archaeological context, whereas a lighter fracture surface is most likely to show a break which occurred more recently (White and Folkens 2005, 51). The presence of peri-mortem breakage, its location and a description was recorded and photographs of the break taken. The schematic representation of fracture types provided by Lyman (1994, 319) has been used to classify the type break observed (Figure 8).

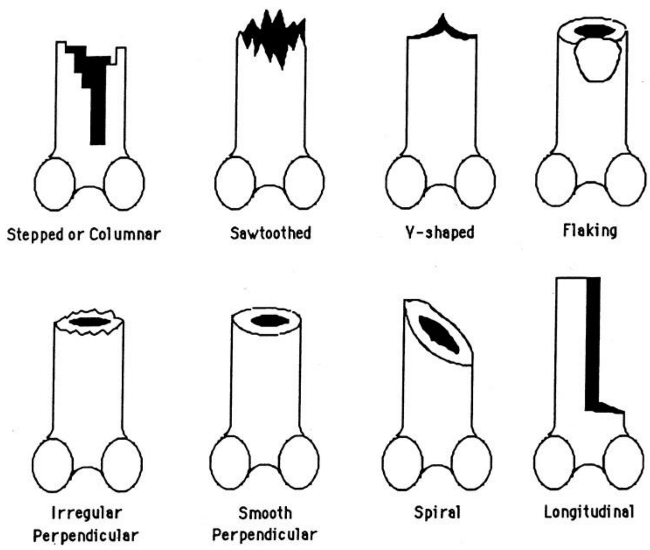


Figure 8: Schematic of bone fracture types (Lyman 1994, Figure 8.4)

2.2.8.7 Other cultural modification

Evidence of any other cultural modifications present on the bone were also considered when analysing the bone, but nothing of this type was observed.

2.3 Assessment of skeletal element frequencies

There are a number of methods established by zooarchaeologists to assess the relative frequencies of skeletal parts as a means of quantifying whether the skeletal specimens present in the bone assemblages were the result of cultural actions by humans, for example butchery, or taphonomic factors devoid of human influence, for example weathering of bone (Lyman 1994, 223).

The most commonly used unit for quantifying bones within an assemblage in human bone studies is minimum number of individuals (MNI) and it is this unit that has been applied in this study. It is important to summarise the specific meaning of MNI in a zooarchaeological context in order to further understand how it has been applied to the human bones in this study. In vertebrate taphonomic studies MNI is used to record the minimum amount of individual humans/animals to account for all of the kinds of identified skeletal elements present in the assemblage (Lyman 1994, 100). Identified remains could be simply identified to taxon or more specifically identified to skeletal element.

In zooarchaeology the unit *NISP* quantifies the **n**umber of **i**ndividual **s**pecimens **p**er taxon and merely counts all of the skeletal specimens (bone or tooth or fragment therefore) which have been identified to taxon and skeletal element (Lyman 1994, 100-102). It therefore provides a count of identified bones within the assemblage. The unit *MNE* has commonly been used as the definitive unit for representing the **m**inimum **n**umber of skeletal **e**lements (Lyman 1994, 100-102). MNE can be applied not only to complete skeletal elements but also to portions of a skeletal element (specimens) and to multi-element portions of a skeleton. MNE is an attempt to adjust the NISP figure to account for if two (or more) bone fragments can derive from the same individual skeletal element. The analyst can take into account the epiphyses present, age and sex of the specimens in order to work out the MNE which are represented by both the complete and fragmentary bone present in an assemblage.

Both NISP and MNE provide quantification of the numbers of bones in an assemblage but they do not clarify how many individual animals are represented by the assemblage. *Minimal animal unit* (MAU) is a unit introduced by Binford to standardise the observed frequency of skeletal parts according to their frequency in one animal (Binford 1984b in Lyman 1994, 104). Binford calculated the MAU by dividing the observed bone count (MNE) of each skeletal element by the number of times that unit occurs in a complete skeleton. When the MAU is calculated using the NISP figures, it can be misleading as in reality skeletal elements like the skull are more prone to fragmentation than extremities and yet in its fragmentary state it is still recognisable as human, particularly the jaw and teeth, and thus it is more likely to have a larger NISP. MAU provides quantification of the potential number of individual animals which were present in order to account for all of the specimens which have been identified to skeletal element.

These units; NISP, MNE and MAU, are more suited to large assemblages of faunal remains where multiple individual animals are present as a means for disentangling abundant skeletal specimens belonging to several taxa. None of these zooarchaeological quantification methods are suitable for use in this study, where the human remains assemblages are small and the potential individuals are few in number.

The frequencies of skeletal specimens quoted in this study are representative of NISP but it provides only an assessment of amounts of specimens present. The methodology applied to this study recorded each individual specimen separately, in order to provide detailed analysis of the human remains, but this means that a NISP or MNE score would distort the assemblage profile: for example, a single disarticulated tooth would be recorded as one but a mandible with teeth in situ would also be recorded as one specimen.

In the assessment of skeletal specimen profiles teeth have been omitted from discussions. Teeth have in some cases been recorded individually as they have been removed and recovered from the mandible or maxilla post-mortem but sometimes, where they remain in situ post-mortem, they have been amalgamated with the recording of the mandible. Additionally, teeth are not counted in the number of expected bones for a complete skull (Table 1) and therefore to include them in any quantifications of skeletal specimens would skew the results.

Throughout this research, counts of specimens present are quoted as NISP but the minimum number of individuals (MNI) are calculated and used to provide context to the counts of bones. The MNIs quoted provide an illustrative figure for the very least numbers of individual skeletons that possibly made up the assemblage. They were calculated using the NISP figures and primarily considering the following criteria; any repeated skeletal elements and any securely demonstrable difference in age or sex of the specimens. Where there was strong stratigraphical evidence of a separation of individuals this was also taken into consideration.

2.4 Dating

2.4.1 Calibration

In this study, only calibrated radiocarbon dates have been used and are quoted as “cal BC” at the two sigma confidence level. This confidence level means that there is a 95.4% probability that the real date falls within the range quoted. Where dates were provided as cal BP (before present) they have been converted into cal BC in order to aid in clear comparison of sites.

All dates, unless otherwise stated, have been calibrated specifically for this study to ensure that the quoted dates apply the most up to date correction data. Dates from sites located in the northern hemisphere have been calibrated using the online calibration program OxCal 4.2 with the IntCal13 calibration curve (Reimer et al. 2013).

2.4.2 Marine reservoir effect

Dating samples which have derived their carbon-14 from marine contexts, whether that be because they lived in the sea, for example fish and molluscs, or because they consumed marine organisms, for example humans eating fish, exhibit a depleted amount of carbon-14 in their profile (Ascough et al. 2009). This is due to the fact that the ocean has a comparatively smaller proportion of carbon-14 than the surrounding atmosphere because of circulation of water masses mixing surface water with much older upwelled waters as well as the transfer rate of atmospheric CO_2. Subsequently, marine samples display radiocarbon ages which are, on average, 400 years older than contemporaneous terrestrial samples (Ascough et al. 2009). This phenomenon is known as the Marine Reservoir Effect (MRE).

Dates which have been taken on marine dwelling organisms or those which might have fed upon marine organisms should be corrected for MRE using a specific calibration curve: Marine13 (Reimer et al. 2013). This calibration curve uses the global average marine reservoir correction of c. 400 years and accounts for fluctuations over time (Ascough et al. 2009; Stuiver and Kra 1986).

The Marine 13 calibration curve is only a global average and specific geographical locations display distinct differences from this average. Thus, it is also necessary to provide a local geographical correction which is known as the ΔR (delta-R) number. It is often very difficult to provide a precise calibration on marine dates as the ΔR values are very spatially and temporally specific so they should directly apply to the area and period which is being calibrated (Milner and Craig 2009).

The online Marine Reservoir Correction Database (MRCD) (Stuiver et al. 2014) allows ΔR values for the area of study to be located and averages between ΔR values to be calculated where there is more than one in the area in question. A recent study has sought to provide accurate and specific ΔR values for the Atlantic coast of Scotland during the Holocene, by comparing meticulously sourced terrestrial and marine samples (Ascough et al. 2007; Ascough et al. 2009). This work demonstrates the complexity of achieving rigorous marine correction data.

There are further difficulties in the application of marine reservoir correction when dealing with human remains. Humans in the past are likely to have had mixed diets containing both terrestrial and marine resources which would mean that the ΔR figure for humans would differ from that obtained on shellfish. This is due to the fact that carbon isotopes are incorporated into bone collagen from a different source than in shellfish which means that correction of radiocarbon dates for the marine reservoir effect could overestimate the effect, providing ages which are too young (Barrett et al. 2000). However, use of the standard IntCal13 curve (Reimer et al. 2013) on samples which have mixed diets, risks producing dates which are too old as it does not account for any marine contribution to the diet.

Therefore, it is often necessary to estimate the proportion of marine foods in the diet so that a proportional marine correction can be made during calibration. Barrett et al. (2000) detail a method for calculating the percentage of marine carbon in a sample through a linear interpolation of the $\delta^{13}C$ content of samples of known c.100% marine and c.100% terrestrial diets. In order to do this, endpoints need to be defined which represent extreme marine and terrestrial diets: in the case of Barrett et al.'s study the terrestrial endpoint used was from samples taken from the $\delta^{13}C$ values of an inland burial ground in medieval Norway (Barrett et al. 2000, 539). Their marine endpoint was taken from the $\delta^{13}C$ value of Mesolithic human remains from Oronsay shell midden (Barrett et al. 2000, 539) which have been cited in the literature as portraying a predominantly marine diet (Richards and Mellars 1998; Richards and Hedges 1999a; Richards and Hedges 1999b).

Using these endpoints the, $\delta^{13}C$ value of the samples being studied were compared to the defined endpoints. Each 1‰ difference from the endpoint equated to approximately an 11.6% change in the make-up of the diet (Barrett et al. 2000). Using this method, the proportion of marine and terrestrial resources contributing to the diet can then be calculated and these values can be applied to the calibration. A mixed marine and terrestrial calibration curve is then compared to the dates (Barrett et al. 2000; IntCal13 based on Bronk Ramsey 2009) to provide a more accurate calibration result.

Milner et al. (2004) have highlighted the problems in assuming that dietary signatures are distinctly different between Mesolithic and Neolithic populations. Indirect marine consumption can increase the marine signature of human bones and small sample sizes can mean that assumptions are made about whole populations based on the diet of only a few individuals (Milner et al. 2004). Thus, only where a definitive $\delta^{13}C$ value is provided for human bones is it possible to know the probable proportion of marine and terrestrial carbon in that person's diet.

The research presented in this thesis only applies marine correction to dates obtained on human bones where the $\delta^{13}C$ value is known for that bone. The proportion of marine carbon in the diet is estimated using Barrett et al.'s method (2000) and a mixed calibration curve (IntCal13 based on Bronk Ramsey 2009)is applied.

2.5 Conclusion

In order to complete primary analysis on the disarticulated bones from shell middens, standard osteological methods have been carried out with some alterations to address the nature of this particular type of data. Further analysis was required to develop an understanding of the taphonomy of the bones from each of the case studies, in order to evaluate the nature of deposition. The defined terminology relating to specimens and elements along with the quantification methods of MNI and NISP are used in this thesis to assess the proportions of skeletons present at the case study sites and the methods outlined here are used in the following chapters to consider how the disarticulated bone came to be deposited in the shell middens.

Chapter Three: Taphonomy of burial and disarticulation

3.1 Introduction

The chapter aims to investigate how intentionally disarticulated human remains may be distinguished from complete inhumation burials when only commingled bones are recovered, such as those often found within shell middens. This is examined using two approaches: first, the variety of funerary and burial treatments given to human remains is explored through the use of ethnographic examples of burial rituals; secondly, taphonomic effects on burial remains are discussed to outline the possible human and non-human factors which might cause burial remains to become fragmented and disarticulated. There is value in addressing both of these areas of research side by side because the two fields of study share a concern for the processes which form archaeological deposits (Gifford 1982, 93) and as such both contribute to our understanding of the potential causes for disarticulated remains to be found in shell middens.

Two case studies are presented in order to examine the taphonomic processes that can occur in inhumation burials located in shell middens. The first investigates the site of Janaba 0004, Farasan Islands, which is poorly preserved and the second examines a cist burial from the Carding Mill Bay site, Scotland, which has been disturbed in antiquity.

Finally, by considering the skeletal element profiles in both of these test cases, combined with taphonomic theory and ethnographic examples, hypotheses are presented which predict the patterning of bones that might be expected in six different burial scenarios. These hypothetical profiles will then be used in later chapters to inform the interpretation of skeletal element assemblages from shell midden sites.

3.2 Ethnographic examples of dealing with the dead

In Britain, and many other western societies, people have generally become distanced from the practicalities of death and decay with burial processes becoming sanitised so that the mourners have little contact with the corpse. The bodies of the dead are given to strangers to be prepared and stored for burial, a fact which some other cultures can find shocking (Barley 1997, 21).

Around 70% of British funerals are cremations (The Federation of British Cremation Authorities n.d.) and perhaps one of the reasons for their popularity is that they are a quick and clean method of avoiding the horror of physical decay (Barley 1997, 39).

Ethnographic studies show that very different attitudes to death and burial customs do exist and people can be much more engaged with the transformation of the fleshed body into dry bones than in western societies. Ethnographic examples highlight the range of potential burial practices that should be considered when assessing archaeological assemblages.

One example is the custom of multi-stage burials (primary and secondary funerary rites) which are thought to be linked to the idea that death is not a single event but involves transforming a body from the living state to the ancestor state through a transitional phase known as liminality (Metcalf and Huntington 1991; Van Gennep 1960, 146). Hertz's study of the Dayak in Borneo showed that these people believe that the physical transformation of the dead body into clean bones mirrors the spiritual journey of the soul from the living population to the dead ancestors (Hertz 1907 as cited in Parker-Pearson 1999, 50). The time it takes for this transition to occur is not always directly connected to the length of time that it takes for the body to become skeletonised. For example the Irquois Indians in the US and Canada lay their dead out until a specified festival when bones are collected and then buried (Henderson 1987, 50). Similarly the Ashanti people in west Africa place their dead in a coffin on stilts for eighty days and nights before reassembling the bones (Rattray 1959, 115).

There is often a liminal period between the physical death of an individual and their passage into the next world in order to give the family time to arrange (and in some cases pay for) the funeral. For example the Torajan people from Indonesia wrap the bodies of their dead in many layers of cloth and keep them in their homes until absent family members return and they have the means to arrange a funeral (Barley 1997, 54). There are practical considerations when delaying the burial of a body and these are normally addressed in the funerary ritual; in the Torajan case the layers of cloth absorb the liquids of putrefaction and quite soon after this the bundle becomes fairly innocuous (Barley 1997, 54). One family observed by Barley kept their grandmother in their house for three years, but she was considered "sleeping" and not actually "dead" until she actually left the house (Barley 1997, 54-5).

A common factor in ethnographic observations of burial rites involving secondary burial and long liminal stages is that the integrity of the skeleton and its articulation is not an important part of the ritual. The Iroquois Indians in the United States and Canada bury the disarticulated bones of their dead during a special festival which can take place up to ten years after the death occurred (Henderson 1987, 50). The Ashanti from Ghana make only a cursory attempt to re-articulate long bones and ignore smaller bones such as the vertebrae after a defined period of decomposition (Rattray 1959, 115). In Balinese burial practices bones are collected for secondary cremation rites after a set period of primary decomposition, but the ground is only roughly raked over and the cremation takes place whether or not any bones are found (Metcalf and Huntington 1991, 101).

The disarticulation of the body is not always a by-product of another funerary rite; some cultures actively aid the disarticulation process by defleshing the bodies themselves in order to practice consumption rituals. For example, the Trobianders and Hua of Papua New Guinea both have death practices requiring the relatives of the dead to eat the flesh or suck clean the bones of the dead in order to release that person's spirit back into the world of the living (Barley 1997, 94 + 103).

The Hau people of New Guinea believe that the finite *nu e*ssence is contained within everyone and is vital for the health and productivity of the group. Therefore, when someone dies their children must consume their flesh in order to pass the *nu* from one generation to the next (Barley 1997, 94). Similarly, the Melanesian Trobrianders believe that it is a son's responsibility to suck the decaying flesh from the exhumed corpse of his father in order to release his spirit across the water (Barley 1997, 103).

Such interaction with the flesh of the dead seems abhorrent to western ideals but is actually no less reverential than our own customs. The Trobrianders recognise the unpleasant nature of the act which they must perform. It is seen as repayment for the care that the father showed for the son by cleaning his faeces and urine as a baby; and by carrying out the act the son is dismantling his father the way that the father constructed him (Barley 1997, 103).

A further example of the complexities of cannibalistic practices by ethnographic populations is provided by the Binbinga of Australia who believe that the community retains the strength and qualities from the dead person when selected members of the group incorporate the special qualities of the deceased into their own bodies by consuming the flesh (Hertz 2004, 202). An additional purpose of the Binbinga's cannibalism is that the deceased is spared the indignity and horror of a slow decomposition by transforming the bones to their final clean state almost immediately (Hertz 2004, 202).

The universality of death produces a variety of human responses, some of which have been highlighted here, and even though they might not seem very similar they are linked by the fact that they are not random acts but are meaningful and expressive (Metcalf and Huntington 1991, 24). It is this meaningfulness of burials and funerary acts which define the human response to death as unique; chimpanzees have responses to death which are expressive but only human dealings with the dead hold *cultural* meanings (Pettitt 2011, 2).

These definitions of human burial as being culturally meaningful simply because of the fact that they are human acts, leads to a questioning of the assumption that fragmentary human remains in a shell midden were simply strewn on the nearest rubbish heap. Fragmentary remains contained within shell middens should be studied from the perspective that they are likely to have been the result of a purposive, culturally expressive, act of human funerary behaviour and that this act might have involved a complex process. That is not to say that the remains on a shell midden did not originate from an inhumation burial placed on or within the mound of shells, but that as archaeologists our interpretations should be based not on our own experiences alone but on knowledge of ethnographic accounts of burial as well as understanding of taphonomy in order to interrogate the remains and provide a best account of what led to their inclusion in these contexts. By understanding that burial practices can be much more involved in the decay processes which transform a body into a skeleton it is easier to see how disarticulated human remains in shell middens might have been more than just the result of disturbed inhumation burials.

3.3 Taphonomy

Taphonomy (from the Greek for laws of burial) has been a popular area of research in archaeology since the 1960's in order to understand the processes by which a living thing is transformed into the bones sitting on the researcher's desk (O'Connor 2004, 19). Much work has been done by zooarchaeologists on the taphonomy of vertebrate animal remains exemplified by Lyman's seminal work (1994). The study of taphonomy was quickly taken up in human remains research (Nawrocki 2009, 284) and then into forensic cases. However, as this new area of research grew, so did the misconception amongst archaeologists that taphonomy dealt with the loss of parts of an assemblage through *natural* processes (Lyman 2010). Lyman categorically states that taphonomy concerns the transition of a living thing from the biosphere to the lithosphere (Lyman 2010, 3) by both natural and cultural practices. He poses a series of questions which aid in understanding the scope of taphonomy:

> "Does the prehistoric specimen of concern display any attributes that make it unlike a normal (modern) specimen of the same kind? Is it distorted, broken, scarred, discoloured, burned, mineralized, disarticulated? If so, why? Is the difference representative of a pathology that was caused when the organism was alive, or is the difference post-mortem and this taphonomic?" (Lyman 2010, 5)

These questions are the basis on which this research assesses how commingled and fragmentary human remains come to be found in shell middens. In order to question the bones in this manner, some background about types of human and non-human taphonomy is required.

3.4 Human taphonomy of burials

3.4.1 Primary and secondary burials

The differences between primary and secondary burials are important in assessing the nature of fragmentary remains in shell middens. Ethnographically, multi-stage funerary rites are concerned with transitioning the body from a state of living to death by transforming the body. From a taphonomic perspective primary burial involves the body (or bodies) being placed in one location of final deposition which has been chosen for *its* use alone and where all decomposition takes place (Andrews and Bello 2006b, 17; Duday 2006, 33). Secondary burials are characterised by the body being subject to at least two stages of burial practice where the bone is deposited in one locale where soft tissue decomposition takes place, before the dry bones are moved to another location (Roksandic 2002, 109; Duday 2006, 45). The presence of movement and delay is essential in secondary burials (Andrews and Bello 2006b, 17).

Secondary burial practices therefore involve a greater degree of processing of the body than primary inhumation. This additional processing changes the archaeological recovery of the bones; they are more likely to be out of articulated anatomical position, there might be bones missing and there may be a series of other taphonomic changes to the bones. These changes to the bones would then provide clues to the possible funerary treatments attributed to the body. Presence or absence of these changes can allow the hypothesis to be considered that disarticulated human remains in shell middens are the result of disturbed primary burial.

In order for the body to pass through the liminal phase between life and death secondary burial practices can be performed to aid the physical transformation of the body. The body is first put in a temporary resting place or "provisional burial" so that the necessary transitional processes can occur, not only to the body but to the soul and to the survivors (Hertz 2004, 198). The temporary disposal of the body allows time for the soul to transition from life to death and for the grieving survivors to abide by the taboos of their culture regarding re-marriage and mourning before emerging from this grief to continue with their lives. Therefore the primary (or provisional) burial treatment of the body facilitates the spiritual and ideological transformations that occur at death. There are ethnographic and geographic reasons why the exact nature of these primary burials (and the customs alongside them) will vary, but Hertz identifies a common purpose within them;

“to offer the deceased a temporary residence until the natural disintegration of the body is completed and only the bones remain” (Hertz 2004, 201).

Orschiedt presents evidence for secondary burial at the Magdalenian site of Brillenhöhle, Germany (Orschiedt 2002). He found numerous cut marks on human bone which he suggests is evidence of careful defleshing of the body aiming to “free the skeletal remains as far as possible from their tissue” (Orschiedt 2002, 247). Additionally this study concluded that the lack of long bones from the assemblage, despite the presence of most other small skeletal elements, indicated that selection of small elements had occurred (Figure 9). In fact all of the fragmentary remains from the site can be fitted inside the largest fragment of cranium, suggesting that this was used as a vessel to carry the human remains to the site and deposit them beside the hearth (Orschiedt 2002, 252).

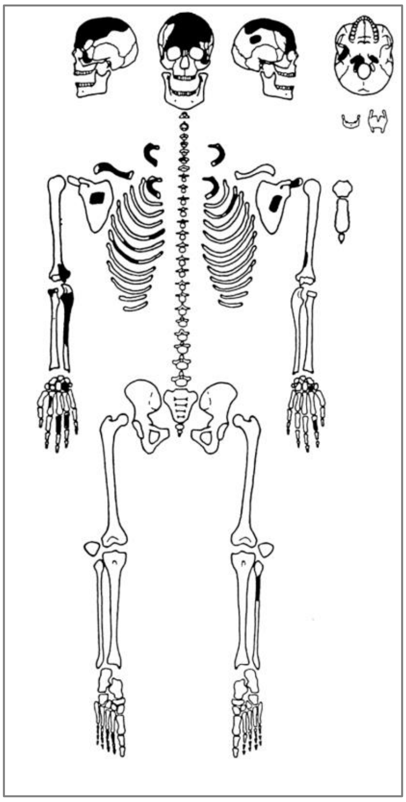


Figure 9: Skeletal element profile of the human remains at Brillenhöhle, Germany (afterOrschiedt 2002 Fig. 3)

However, secondary burial practices are difficult to prove in the archaeological record because in order to conclude that bones have been intentionally removed or selected there needs to be a level of certainty that differential preservation rates and excavator error is not a factor (Duday 2006, 46). In an archaeological assemblage it is often difficult to be certain that all remains have been recovered; nevertheless, secondary burial rites should be considered as a possible explanation when dealing with disarticulated and fragmentary human remains.

3.4.2 Disarticulation of the skeleton

Secondary burial practices carried out on the defleshed bones of the deceased naturally cause the skeletonised bones to become disassociated from anatomical position, or disarticulated. Disarticulation of the skeleton can occur through a variety of means (Hertz 2004, 201). For instance, a body can be laid out and left for natural processes of decay to occur, a process known as excarnation; bodies can be temporarily buried whilst the flesh decomposes before the bones are dug up and secondary treatment enacted; or active disarticulation can be practiced by cutting the soft tissue from the bones either with the intention to remove the flesh or to disarticulate the skeleton.

Animal taphonomy studies draw attention to the difference between defleshing, which produces few marks on the bone, and disarticulation of a body, which creates marks in predictable areas of the skeleton. The process of defleshing an animal gives little opportunity for the tools to come into contact with the actual bone, except in the skull and lower legs and arms (Binford 1981, 106-7). However active defleshing of the bone with cutmarks resulting in dismemberment of a body can be found in areas of articulation where the muscles attach such as the proximal and distal ends of long bones (Binford 1981, 107; Graver et al. 2002).

The variety of processes which lead to disarticulation complicate the interpretation of burial practices from disarticulated bone but this should not prevent the consideration of these remains. An assemblage of bones where there is a specific predominance, or omission, of areas of the skeleton might suggest that some selection and gathering occurred which favoured certain bones. For example the Ashanti's favouring of long bones (Rattray 1959, 115) would result in two archaeological assemblages; one which contained predominantly long bones and the other which contained a noticeable absence of long bones.

Therefore, skeletal element profiles of disarticulated assemblages are likely to show specific parts of the skeleton favoured or missing but there would be no definable pattern to the expected retention or loss of certain parts of the body. The body parts favoured in secondary burial processing would differ culturally according to the types of practices that were used, but disarticulation should be distinct from non-human taphonomic patterns of bone loss.

3.4.3 Cannibalism

A common interpretation for the presence of disarticulated human remains particularly at shell midden sites is that they are the result of cannibalism (for example Cook 1986; Deacon 1995; Rightmire and Deacon 2001) and it is often the midden context itself which is a primary factor leading to a conclusion of cannibalism. For example, the Klasies River Mouth midden in South Africa contains mostly fragmentary skull specimens with some cut marks and burning (Deacon

1995, 127) but the shell midden context within which these remains were found is used to conclude that the fragmentary bone is a result of cannibalism (Deacon 1995, 127).

Assuming that human remains found in association with food waste are therefore also the result of consumption practices oversimplifies the picture. Consideration of more than just context is needed to infer cannibalism and fifteen indicators of cannibalism were developed by Turner and Turner (in Graver et al. 2002, 312) to test potential cannibalistic assemblages (Table 5).

Taphonomic signature of cannibalism	
1	Single short-term depositional episode (indicated by stratigraphy), resulting in a lack of bone weathering and animal scavenging
2	Bone preservation good to excellent
3	Animal gnawing occurs on fewer than 5% of all elements
4 *	Vertebrae are usually missing
5	Most body parts are disarticulated
6	Peri-mortem breakage occurs in 40-100% of skeletal elements
7 *	Head, face and long bone breakage is universal
8	High bone fragment counts. Body reconstruction is difficult because of high rate of unaccounted for bone loss
9 *	Breakage by percussion hammering against an anvil with spiral and compression fracturing very common
10 *	Burning of skeletal elements present in 2-35% of assemblage
11 *	Cut marks associated with butchering and skinning in 1-5% of bone elements
12	Taphonomic sequence includes cutting, breaking and burning
13	Human bone pseudo-tools may be present in a very small number of cases
14	Frequency of alteration: 95% for peri mortem breakage; 20% for burning; 3% for cut marks; and 2% for gnawing or chewing
15 *	Evidence of pot polish present, smooth polish on ends of bones from cooking vessels

Table 5: Taphonomic indicators of cannibalism (after Graver et al. 2002). The critera marked with * represent Turner and Turner's minimal taphonomic features that should be present to indicated cannibalism.

These criteria have received criticism for providing a circular argument and failure to consider other explanations of the remains (McGuire and Van Dyke 2008, 22) but they do serve as a prompt for further investigation of the remains, rather than drawing simplistic conclusions without considering all of the evidence. Even if the use of these criteria allow a conclusion that cannibalism is likely to have occurred, the reason behind the cannibalistic practice still needs attention.

Cannibalism is traditionally seen as an aggressive or detrimental act taken upon a body in a hostile manner and has been used as an easy way to debase a culture by associating them with a practice seen as immoral and depraved (Knüsel and Outram 2006, 253). “Ritual” treatment of a body is thought to show intellect and empathy indicative of humanity but cannibalism is akin to “gross animality” but both types of act are simply different responses to the practical problem that fellow humans are made of meat (Barley 1997, 14). The common use of cannibalism as an explanation of disarticulated and fragmentary remains in the past was connected to the desire to highlight the distance and contrast between the lives of ancestors and our own (Knüsel and Outram 2006, 253). In more recent years the variety of secondary funerary practices which can be employed on a human body and their potential for producing fragmentary and disarticulated remains has been more widely recognised and there has even been a tendency to veer away from an interpretation of cannibalism in order to favour interpretations of practices such as excarnation (see Knüsel and Outram 2006, 254 for discussion).

In practice there are a variety of reasons why defleshing of the corpse, and possibly then consuming the flesh, might be carried out, encompassing both mortuary and non-mortuary functions. These are summarised by Pettitt (2011, 46) and include;

- non-mortuary cleaning of the bone minimising putrefaction for disposal
- mortuary cleaning for purification, secondary burial, use of bone as portable relics
- nutritional consumption in response to stress
- regular nutritional consumption
- pathological nutritional consumption
- aggressive social consumption
- passive social consumption (eg. to obtain strength/ nature of consumed)
- mortuary consumption to retain element of attachment to deceased
- mortuary consumption involving transformation
- means of ritual curation of the dead

This variety of cannibalistic purpose is supported by the ethnographic literature which demonstrates a multitude of reasons behind the practicing of cannibalism. The underlying motivations behind cannibalism are varied and often have a reverential and thoughtful origin, far removed from the dishonourable and animalistic purposes of cannibalism which are most often brought to mind when the subject is discussed.

Therefore, the mere placement of human remains into a refuse context such as a shell midden should not be seen as being suggestive of cannibalistic activity. There are a number of criteria which have to be met (Table 5) in order to distinguish the possibility of cannibalism, and even if cannibalism is indicated using these criterion the assumption that the human remains were then disposed of into the midden should be avoided. Where mortuary cannibalism may have taken place there is every likelihood that further, considered and intentional, mortuary treatment of the cleaned bones would also have been practiced.

3.4.4 Cremation

The term cremation refers to the act of burning a body on a pyre and should not be confused with cremation burial (McKinley 2004a, 10) which refers to the bones that have been part of a cremation being deposited in the archaeological record. Today cremation is a popular choice of burial practice for a large proportion of the population, and has had periods of popularity since prehistoric times.

Burning of a body on a pyre leaves little but charred and warped bone remains (Parker-Pearson 1999, 7). Even a short time after a modern day Balinese cremation took place there were no visible traces remaining (Downes 1999, 25). As a result of the limited physical remains from a cremation this type of processing of the body is often little understood and in many cases can form only part of a series of ritual formation processes (McKinley 2004a, 9).

During the cremation process bone is subjected to extreme heat which causes the colour of the bone to change according to the temperature that the bone was exposed to. For example temperatures around 200-300˚C give a brown/black colour whilst a white to blue/grey colour is achieved at temperatures around 800˚C (Buikstra and Ubelaker 1994, 95). It is also possible that the pattern of colour change on cremated bone can indicate whether the human remains were in an articulated or disarticulated state prior to burial. Bones with thick soft tissue cover, like joint surfaces, would be protected from the heat of burning and therefore show less colour change than other, less thickly covered bone (Buikstra and Ubelaker 1994, 96).

Alongside the colour change evidence on cremated bone, cracking and warping also occurs. A characteristic “checking” type of cracking can be found on green bone (bone which retains its organic component) where cracks appear longitudinally and laterally to the main axis of the bone (Buikstra and Ubelaker 1994, 97).

Where human bone displays evidence for large scale burning in the form of distinct colour change to white, blue/grey or calcination of the bone as well as the presence of cracking and warping then this bone is very likely to have been subjected to cremation and is confidently termed as “cremated bone”. However, where the evidence for burning is less widespread and more localised on only part of the bone, the processes leading to the bone being burned are less clear and it is then preferentially termed “burned bone”. A common interpretation for “burned bone” is that it is the result of cannibalism (Graver et al. 2002, 317) as bone is burnt during the cooking process. However, there is potential for the burning to be incidental to another funerary activity taking place on the bone and should not in itself be used as evidence for cannibalism.

3.5 Non-human taphonomy of burials

In addition to the human factors of taphonomy on burial remains discussed above, there are a number of non-human factors which also have an effect on the preservation of bone and its appearance in the archaeological record. These must be understood in order to draw stronger conclusions about the taphonomic history of the bones. It is possible that some non-human taphonomic processes could occur as a result of deliberate human action, so their presence does not exclude human funerary processes from taking place but does allow better informed interpretations to be drawn.

3.5.1 Decomposition and intrinsic bone survival

After death, the taphonomic processes affecting the body would begin with autolysis (enzyme attack on soft tissue), then putrefaction (soft tissue degredation by micro-organisms), followed by liquefaction (soft tissue and organs become liquefied) (Dent et al. 2004, 577-83). These initial decomposition processes will not have a significant effect on the survival of individual bone elements as the early soft tissue degradation caused by microbes might have some effect on the histology of the bone (Hollund et al. 2012, 538). It should not cause an entire bone to be lost prior to skeletonisation.

Once liquefaction has taken place, and the body has been skeletonised, decomposition of the bone structure by inorganic chemical processes takes place (Dent et al. 2004, 584) and there is then the potential for skeletal elements to be lost. They are known as *taphic* taphonomic processes and caused by the action of the geochemistry of the matrix surrounding the bone (O'Connor 2004, 20-1). Weathering and sun-bleaching are taphic processes which can occur if the bone is skeletonised prior to burial (O'Connor 2004, 20-1). These taphonomic processes affecting the bone can be disrupted and altered many times once the bones are buried, if a change in environment occurs (O'Connor 2004, 23).

The intrinsic structure of bone means that some skeletal elements are more likely to survive the effects of taphic processes than others. Long bone is more robust and therefore more likely to survive archaeologically than other more fragile elements of the skeleton (Merbs 1997). Waldron

(1987) also found that dense bones such as the pelvis were more resistant to destruction and thus more likely to be found. In terms of bone density, small, dense and broadly spherical bones like carpals and tarsals, which contain higher proportions of cortical bone, would also be expected to survive well (Darwent and Lyman 2002, 359). Ribs, vertebrae and sternum, which contain large proportions of trabecular bone, were more likely to be affected by decomposition in the soil and survived less well (Mays 1992, 57).

A study assessing the relative survival of each skeletal element at a Romano-British cemetery site in London (Waldron 1987) found that the number of long bones recovered (excluding the tibia) were between 40-79% of those expected for the number of graves at the site. Long bones, specifically the tibia, femur and humerus, were again among the most frequent bones to have survived at an ossuary site in Maryland, United States of America (Ubelaker 2002, 338). Here the bones were subject to secondary burial within the ossuary and the prevalence of long bones was deemed to be a selective decision made by the people depositing the bones (Ubelaker 2002, 339).

In preservational studies which look at bone representation in archaeological cemeteries, carpals, tarsals and extremities, which due to their density should survive well, are often found missing or severely under-represented (Cox and Bell 1999, 945; Henderson 1987; Nawrocki 1995, 62; Waldron 1987). The reason why hands and feet are often underrepresented in archaeological cemetery contexts is not clear, but it is possibly due to recovery and retrieval rates during excavation (Cox and Bell 1999, 949). A study looking at 226 Medieval primary inhumation burials in a cemetery in Suffolk found that low numbers of hands and feet bones are due to a combination of preservational and retrieval factors (Mays 1992, 57).

The studies of taphonomic factors affecting human bone survival are at odds; bone density studies suggest that tarsals and carpals, along with the other extremities, should survive well in an assemblage, whereas forensic and archaeological examples often report hand and foot bones lacking. Massett argued that where such conflict exists, archaeological examples should be considered more relevant (Massett 1987, 131 in Roksandic 2002, 103).

Bone survives best in neutral or slightly alkaline environments (Dent et al. 2004, 584). A shell midden matrix creates favourable conditions for the preservation of bones because as shell is broken down the calcareous shell matrix produces an alkaline environment which enhances the survival of the mineral components of bone (Sobolik 2003, 25). A study which took pH readings from 60 points within a Florida shell mound demonstrated a median pH value of 7.8 which is slightly alkali and perfect for bone preservation (Scudder (1993) in Reitz and Wing 1999, 117).

The shell midden environment also creates advantages for the survival of smaller bones, which traditionally do not survive well in the archaeological assemblage. The morphology of the shell creates a type of “umbrella” which channels the water away from the small bone underneath it and therefore limits the change in pH value around the bone and stabilizes it at a slightly alkaline level which is conducive to bone survival (Reitz and Wing 1999, 117). Additionally, the shape of the shell provides protection from mechanical fracturing and fragmentation to the smaller bones through trampling (Reitz and Wing 1999, 117-8).

3.5.2 Disarticulation

A general pattern for the sequence of bones disassociating from the skeleton is known from disarticulation studies of mammals (such as Andrews and Cook 1985; Hill 1979; Hill and Behrensmeyer 1984). Although these studies focussed their attention on mammals, they showed that the patterns of disarticulation were very consistent between samples and species and as such it is accepted that these results can be applied to the disarticulation of human remains (Ubelaker 1997).

The order in which particular parts of the skeleton become completely disarticulated (Table 6), shows that the scapula and mandible are the first elements to disarticulate while the hands also fragment early in the process. The upper limbs generally tend to become disarticulated before the lower limbs and the spinal column and torso elements are the last things to become disassociated.

The cranial vault is fragile and thus probably less likely to survive intact (Henderson 1987) with particularly the facial bones becoming disassociated from the rest of the skull (Andrews and Bello 2006a). However, in experimental situations, where the relative survival of bones has been assessed, the skull has survived well (Andrews and Bello 2006a) and there are dense portions of the cranium, such as the mastoid process and the petrous temporal bone, which would be expected to survive quite well (Waldron 1987). Additionally, where canine scavenging has been observed, the cranium survives in the vast majority of cases (Haglund 1997, 375). Observational studies on the disarticulation patterns of mammal carcasses agree that the mandible disassociates from the cranium relatively early on in the process (Andrews and Cook 1985; Hill 1979; Hill and Behrensmeyer 1984).

Order of disarticulation	Hill's stage of disarticulation	Skeletal element completely disarticulated
1	2	Caudal (tail) vertebrae
2	3	Scapula
3	4	Mandible
4	7A	Carpals
5	7B	Metacarpals
6	8A	Humerus
7	8B	Distal phalanges (forelimb)
8	9	Proximal and medial phalanges (forelimb)
9	10A	Radius and ulna
10	11B	Proximal, medial and distal phalanges (hind limb)
11	12	Femur and tibia
12	13	Atlas and cranium
13	14	Tarsals and metatarsal
14	15	Ribs
15	16B	Thoracic vertebrae (2-12 separate)
16	17A	Pelvis
17	17B	Thoracic vertebrae (13)
18	18	Lumbar vertebrae (1-6 separate)
19	19A	Lumbar vertebrae (7) and sacrum
20	19B	Thoracic vertebrae (1)
21	20	Axis
22	21	Cervical vertebrae (3-7 separate)

Table 6: Order of disarticulation of mammal skeletal elements (after Hill 1979, Table 1). This can be applied to human skeletal disarticulation.

3.5.3 Scavenging

In studies of disarticulation patterns the extent of the effect that scavenging animals have on the observed pattern is often hard to discern. Scavenging behaviour of animals varies between region and season (O'Brien et al. 2007) but there are often predictable patterns of scavenging behaviour which have been observed (for example Berryman 2002; Behrensmeyer 1983; Binford 1981; Haglund et al. 1989). Haglund et al. (1989) described 5 stages of scavenging activity on human remains:

0. no bony involvement
1. ventral thorax damaged, one or both of upper extremities removed
2. lower extremity involvement
3. only vertebral segments remain articulated
4. total disarticulation

This pattern has been corroborated by further studies on scavenging patterns on other species such as deer and orangutans (Berryman 2002, 491). What these studies show is that carnivorous animals target first the soft tissue rich portions of the corpse; opening the torso and damaging the ribs in order to reach the organs. Additionally, facial areas are easy targets for meat consumption (Berryman 2002, 491) and once these areas have been stripped of flesh the limbs and head are targeted. The vertebral column acts as an anchor point (Behrensmeyer 1983, 98) from which the limbs and head are dragged so that they can be targeted for gnawing. It is also important to remember that during animal scavenging there is a degree of competition present between scavengers which no doubt affects the skeletal distribution. It is likely that the skull and upper limbs would be dragged away from the competition surrounding the main corpse and the associated non high-yield meat elements such as the hands and fingers would be taken along with them as they would still be attached (Binford 1981, 42).

Once the fleshy meaty parts of the body have been depleted in the earlier stages of scavenging the softer articular ends of long bones are targeted (Binford 1981, 51). These areas of bone provide easiest access to the medullary cavity, and the enclosed bone marrow, and this exploitation is characterised by gnaw marks.

Animal gnaw and bite marks are perhaps the clearest indicator of animal scavenging on skeletal remains and can be present in the form of punctures, pits, scores and furrows (Binford 1981, 44). These tend to be common on accessible parts of the skeleton (Ubelaker 2002, 342), meaning that the placement of animal gnaw marks can be used to infer the level of disarticulation and defleshing of the remains.

In sum, animal scavenging of a corpse can be identified by the pattern of disarticulation with skull and upper limbs being the first areas to disarticulate. The presiding pattern of this type of behaviour is that the vertebral column stays intact until the end stages of skeletonisation as it has a low meat yield and is used as an anchor from which the other parts of the body are removed.

3.5.4 Weathering

If a body is left to decompose sub-aerially rather than being buried it is common that weathering of the bone surface occurs after skeletonisation has taken place. Weathering can begin quite rapidly after the bone is exposed (Behrensmeyer 1978) and differing degrees of weathering can be observed on two bones from an individual carcass (Lyman and Fox 1989). As skeletal elements become disarticulated, and the bone is exposed, weathering will begin to occur on those exposed bones while the remainder of the body continues to decompose.

Weathering stages observed on animal bone are commonly accepted signatures on all types of bone and are recommended for use in recording weathered human remains (Buikstra and Ubelaker 1994, 98). The stages of weathering on a bone were documented on samples from a range of environments in the Amboseli National Park, Kenya (Behrensmeyer 1978):

0. Bone surface still greasy and shows no signs of cracking or flaking
1. Bone shows cracking parallel to fibre structure and articular surfaces show mosaic cracking
2. Outermost layers of bone shows flaking and cracks
3. Bone surface is rough and fibrous textured compact bone, all external concentrically layered bone has been removed
4. Bone surface is coarsely fibrous and rough, large and small splinters occur resulting in some bone falling away when moved
5. Bone is falling apart in situ with large splinters lying around what remains of the whole

The extent of weathering displayed on bone is dependent on the environment and provides evidence of both the intensity and duration of exposure; not least the temperature and humidity as well as the pH of the surface on which the bones are placed (Behrensmeyer 1978, 156). In experimental studies, bones which had been exposed for less than three years most often fell into stages 0-2 and those that had been exposed for more than three years never fell into stages 0 and 1 (Behrensmeyer 1978, 157).

Evidence of weathering on bone surfaces in the form of cracks, flakes and splinters is indicative of sub-aerial exposure of the body for some considerable time. In order for it to occur, the body has to have become skeletonised and then remain exposed. Therefore, weathering can be used as evidence of excarnation or exposure of human remains but the absence of bone weathering does not prove that no excarnation occurred. If excarnation was actively practiced as part of a funerary process to remove the soft tissue from the corpse, as has been observed ethnographically, it is likely that once skeletonisation had occurred the bones would be collected ready for secondary treatment before any great deal of weathering could take place.

3.6 Burial processes

Often disarticulated human remains in shell middens are thought to be the result of disturbed inhumation burials and that this disturbance was unrelated to the funerary processes enacted on the body, hence the assumption that a complete and fleshed body was placed or buried on the midden. Decomposition would have taken place and the body would have become skeletonised and incorporated into the midden matrix (Figure 10).

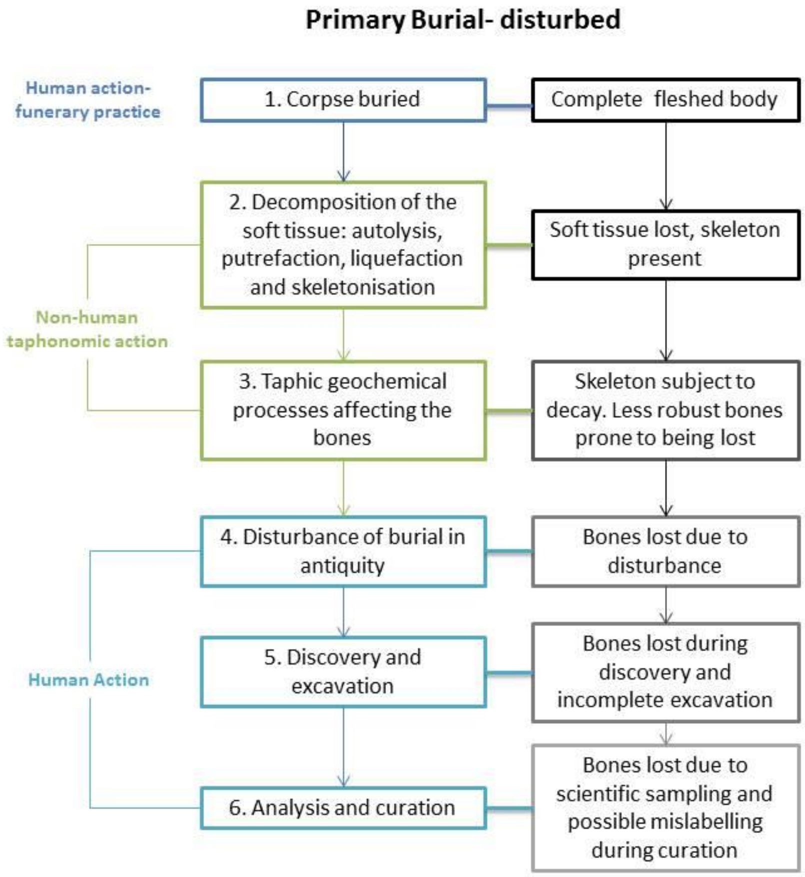


Figure 10: Flowchart summarising the taphonomic processes of a primary inhumation burial which has been disturbed

However, if secondary burial rites were practiced after the body was either wholly or partially skeletonised, secondary processing of the bones would cause the skeleton to become disarticulated; broken up, moved, curated, commingled and perhaps deposited somewhere entirely different from the site of the original primary deposition.

Secondary burial is a plausible cause for fragmentary, disarticulated human remains appearing in shell middens and therefore the difference between a skeleton which has been primarily inhumed and left in situ and a skeleton which has been treated to secondary burial and disarticulation needs to be investigated so that the remains in shell middens can be properly assessed.

Funerary treatments resulting in disarticulation of the skeleton are varied but a specific omission or prevalence of certain bones might indicate that secondary funerary acts were performed on the disarticulated skeleton (Figure 11). The resulting skeletal element profile would need to be compared to expected survival rates of certain bones in order to rule out non-human taphonomic actions resulting in bone loss.

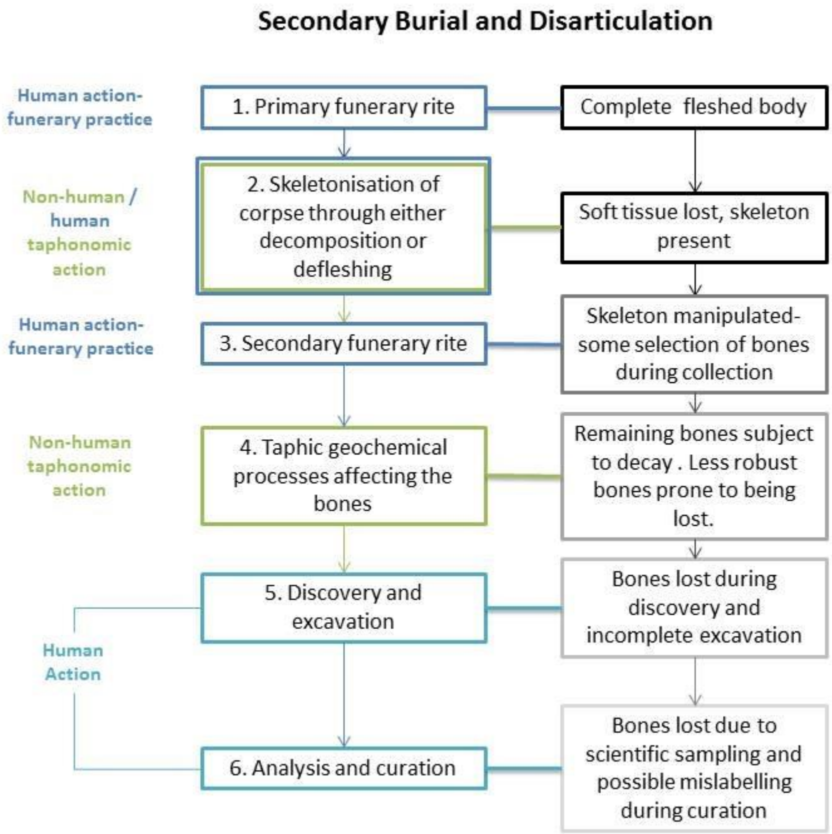


Figure 11: Flowchart summarising the burial processes of a secondary burial leading to disarticulation of the skeleton

3.7 Potential skeletal profiles considering taphonomic factors

Based on the ethnographic examples and taphonomic processes discussed in this chapter it is possible to summarise the findings through a series of skeletal element profiles of bones which are expected to survive in a number of different taphonomic scenarios. These potential skeletal profiles can then be considered in subsequent chapters in order to establish the most likely processes leading to the skeletal assemblages featured in each of the case studies.

3.7.1 Primary burial- poorly preserved

The intrinsic pattern of bone survival can be used to anticipate the bones which would be likely to survive best and therefore be most prevalent in a poorly preserved primary inhumation assemblage. The potential skeletal profile for a poorly preserved inhumation burial is provided in Figure 12.

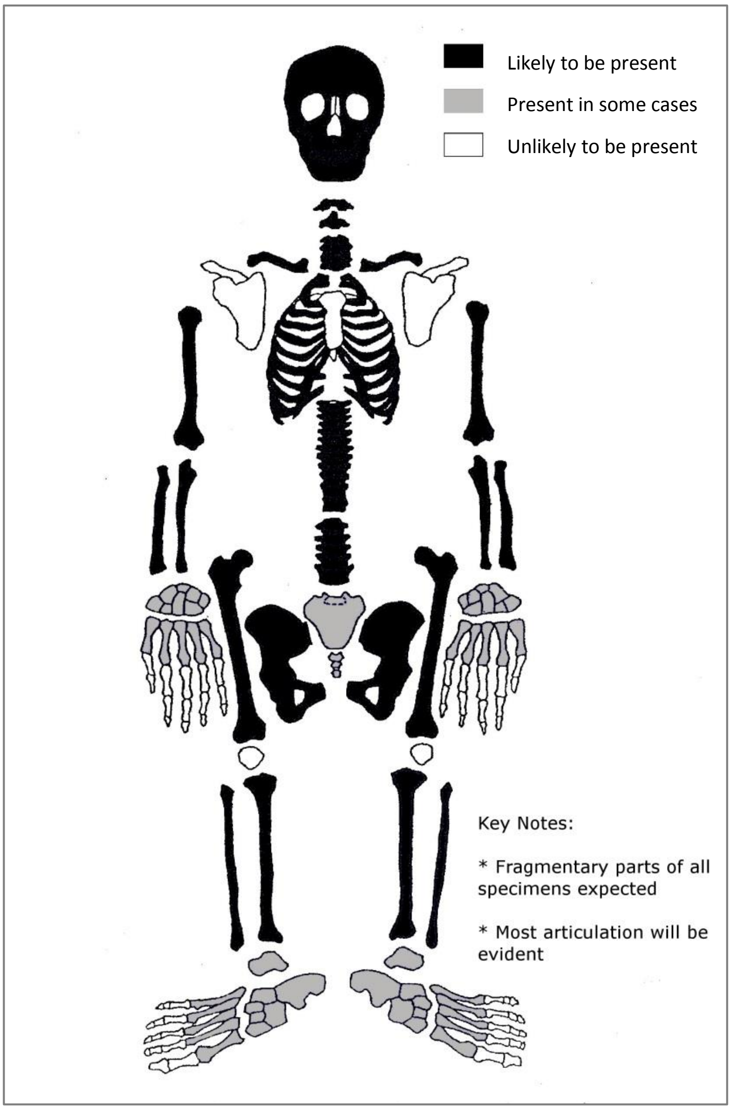


Figure 12: Skeleton diagram showing expected preservational pattern for a poorly preserved primary inhumation burial

Long bones and other robust bones like the pelvis are expected to survive well but smaller bones like extremities, vertebrae and ribs are not expected to survive well. Additionally, the scapulae are unlikely to survive intact because of the fragile nature of their bone morphology. In a shell midden context some smaller bones might be protected by the morphology of the shell so there could be slightly higher than expected proportions of smaller bones.

It would be expected that in a poorly preserved primary burial there would be at least some degree of articulation still present in the skeleton, and at least fragmentary parts of most elements would be present. Careful observations during the excavation process are essential to providing this level of detail but where articulation exists, particularly amongst bones which are among the first to disassociate, for example the mandible, scapula or carpals, then a primary burial is a likely explanation.

3.7.2 Primary burial- disturbed

A disturbed primary burial is likely to produce a skeletal assemblage where some remaining articulation is observed and the specimens present largely correspond to those likely to survive, like the robust long bones and trunk bones. The potential skeletal profile of a disturbed inhumation burial is illustrated in Figure 13. It is likely that if disturbance has caused the breaking up of a burial then there will be whole parts of the skeleton missing (ie. the left side, or the upper body) or that truncation of the burial will be clearly evident.

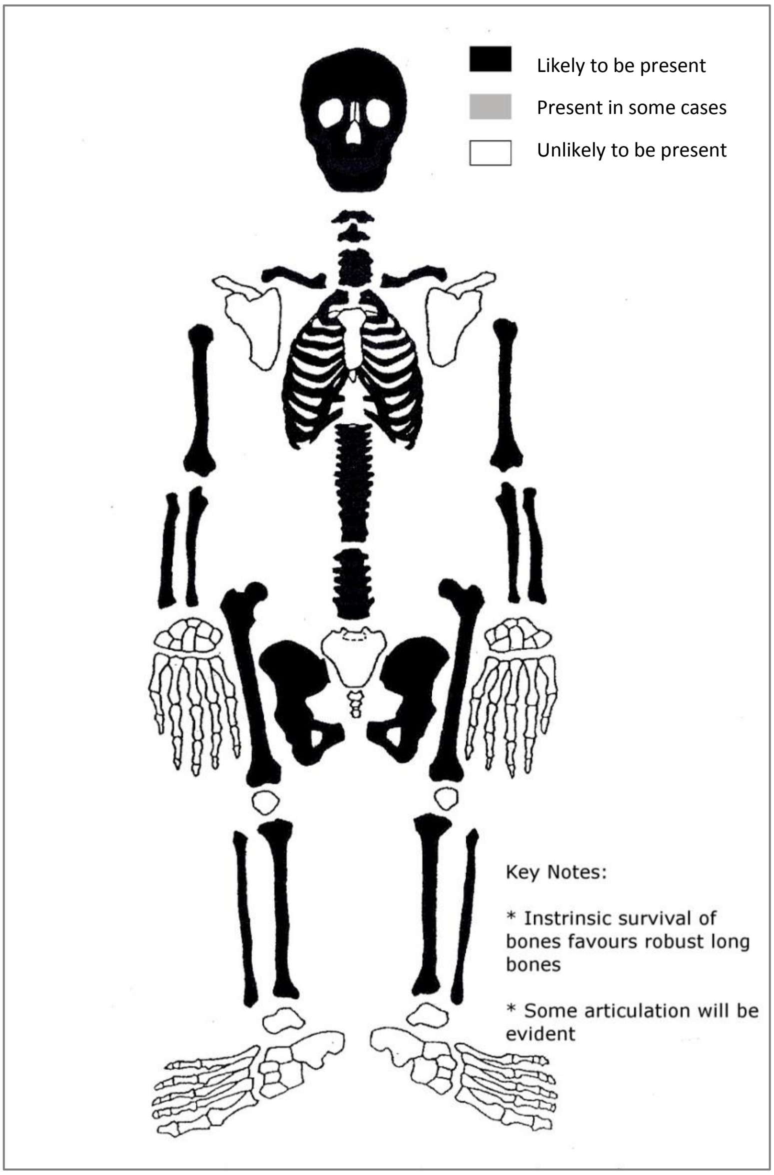


Figure 13: Skeleton diagram showing expected preservational pattern of a disturbed primary inhumation burial

3.7.3 Excarnated burial- weathered

If a skeleton has been subject to prolonged excarnation it can be expected that evidence of weathering will be present on the bones. The degree to which weathering took place will depend on the length of time that the specimen was exposed after the soft tissue was lost. If weathering took place on a body which was exposed but protected from faunal scavenging and not subject to any further secondary treatment then the skeletal elements would be expected to largely retain anatomical position. However, if the remains are disarticulated and there are elements missing then the evidence for scavenging or secondary burial treatment has to also be applied.

In order to conclude that a body was subject to sub-aerial excarnation some weathering would need to be present and some articulation observed in the persistent joints of the vertebrae and torso.

3.7.4 Excarnated burial- scavenged

Further to the weathering expected on excarnated remains, it is likely that the body would be subject to scavenging by carnivores if left exposed and unprotected. The most distinctive indicator of scavenging is animal gnaw marks which clearly point to the remains having been disturbed by fauna. Additionally, the common pattern of exploitation of the corpse by scavenging animals can help inform the potential skeletal profiles of excarnated scavenged remains (Figure 14). There are two potential profiles, one based on the bones found at the site of original deposition, where the scavenging occurred and the other based on a location that scavenged remains were removed to.

A scavenged assemblage is likely to be made up of a largely articulated vertebral column and torso elements. Limbs and extremities are likely to be missing or disarticulated from the rest of the skeleton. If the limbs have been removed then the extremities would have been carried along with them. An assemblage which contains torso devoid of limbs and extremities would be representative of the bones found at a scavenging site whereas one which contains limb bones and extremities only would be representative of a place where scavenged remains were taken in order to avoid competition. Any evidence of gnawing or crushing, particularly on the articular ends of the bones would further support the scavenging hypothesis.

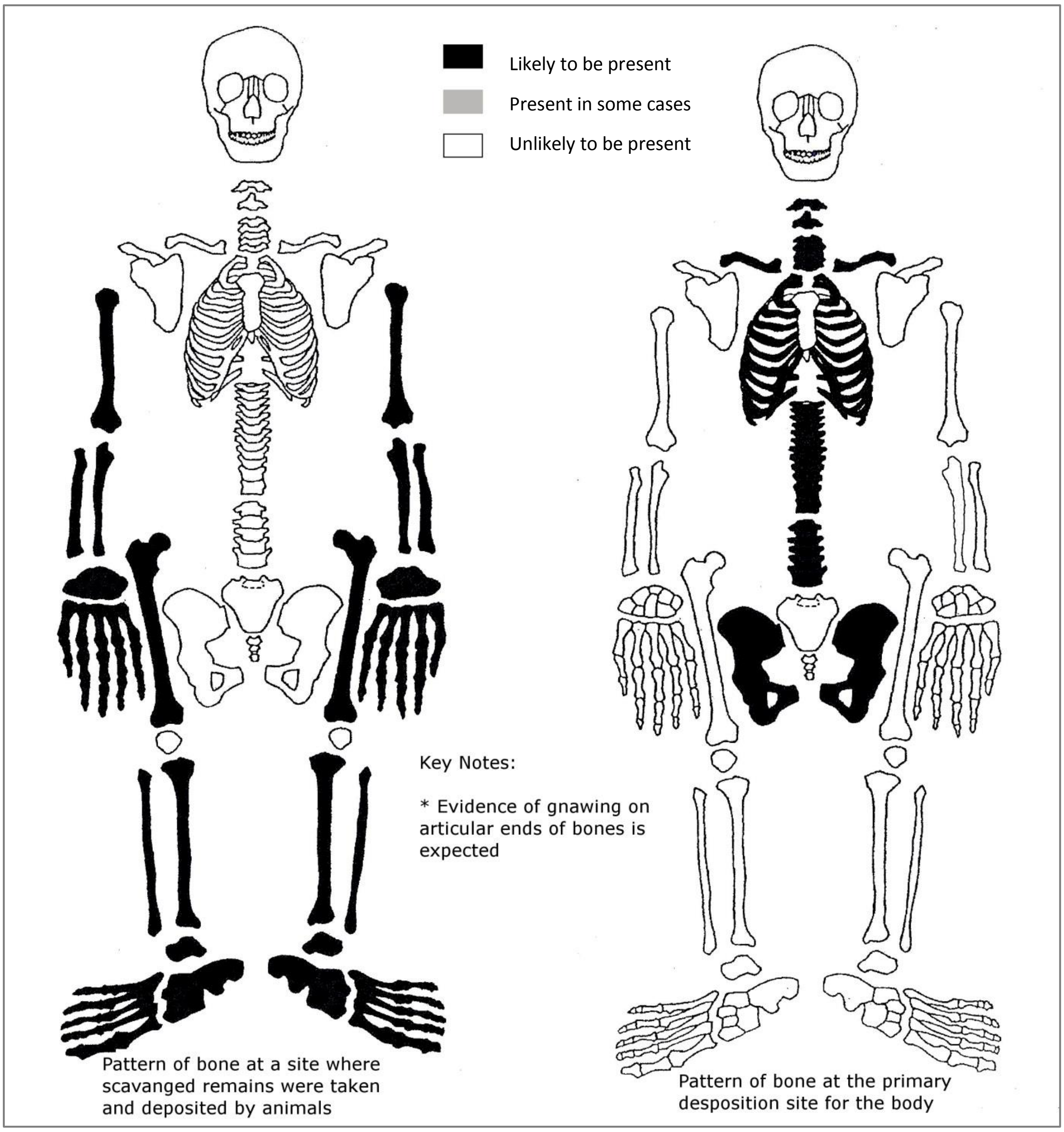


Figure 14: Skeletal diagram showing expected survival of specimens in a scavenged burial. The left hand diagram shows the remains that would be expected in an assemblage of bones taken away from the main body by scavengers to avoid competition. The right hand diagram shows the expected specimens in a site of primary placement of a body which has then been subject to scavenging

3.7.5 Secondary burial / disarticulation

A skeletal assemblage showing some selection in the bones present (or left behind depending on which part of the process is under study) and is not explained by animal scavenging, intrinsic survival rates of the bones or any other of the natural taphonomic factors discussed in this chapter, is likely to be the result of secondary funerary practices. The selection of bones which takes place in secondary burial has been shown by ethnographic examples to differ in the degree to which all of the bones are collected. In some societies this selection process is thorough and collects all of the bones whereas in others little concern is given to the entire skeleton. Therefore, two possible scenarios are represented in the potential skeletal profiles of secondary treatment (Figure 15).

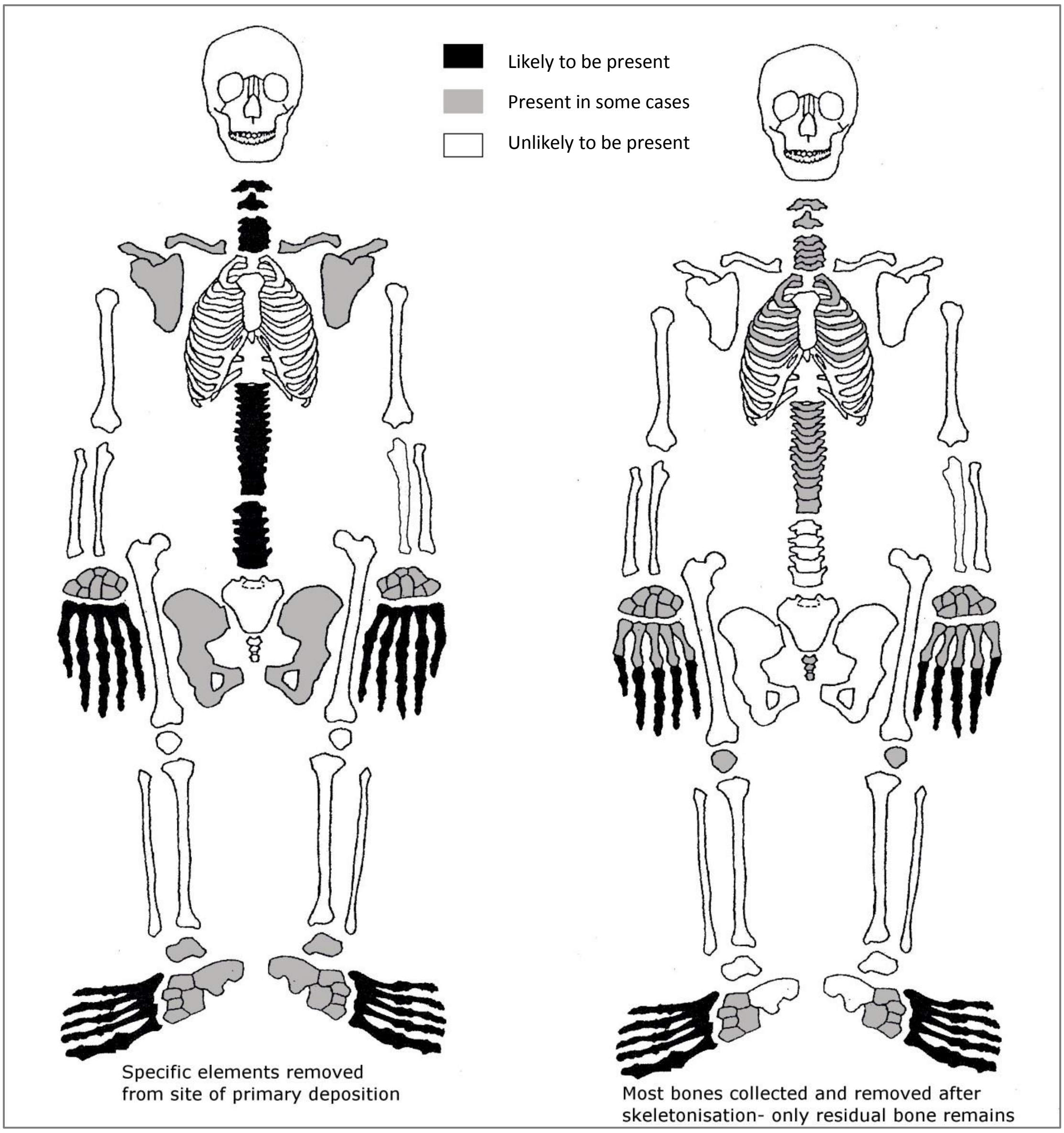


Figure 15: Skeletal diagram showing the possible pattern of preservation for two types of secondary burial treatment. The left hand diagram shows a potential pattern where certain bones have been removed from the site of primary deposition while the right hand diagram shows the pattern expected from a site of primary deposition where most bones have been collected after skeletonisation takes place

A particularly convincing example of this type of evidence would be where an assemblage contains some bones from all stages of the natural disarticulation process; for example the mandible or scapula which disassociated very early on into decomposition, and lumbar vertebral elements and tarsals which are amongst the last bones to fully disarticulate. Evidence of this sort would imply that the body was allowed to fully disarticulate before certain bones were selected for secondary treatment. Where long bones are missing but extremities are present it can be concluded that the long bones were actively removed from the assemblage after the hands and feet had disassociated, which is not what would be expected from a scavenged assemblage or one where the bones were poorly preserved, given the fact that long bones are known to survive better than extremities in the archaeological record.

Intentional disarticulation of the corpse as part of a secondary funerary ritual is perhaps best exemplified by the evidence of cut marks on articular joint areas of the bone, although then the question of cannibalism could be raised. Whether or not the goal of dismembering the body was to eat it or practice other secondary ritual treatments, cutmarks are still evidence that active disarticulation occurred. The reasons behind the evidence of disarticulation and secondary practices might never be known but it is certainly possible to identify such assemblages in the burial record.

3.7.6 Cannibalised remains

Evidence of cannibalism is extremely hard to prove and the context of human remains in a midden should not be enough to draw a conclusion of cannibalism. Instead fragmentary remains, evidence of cutmarks on the bone, missing vertebrae, evidence of burning, possible pot polish and universal breakage of the bones should be present in order to begin surmising that cannibalism might have been present. Cannibalism should also be considered in terms of a secondary burial practice alongside manipulation of the skeleton, curation of remains and caching of bones rather than treated as a separate entity.

3.7.7 Application of potential skeletal profiles in this study

Although the potential skeletal profiles are simplified, hypothetical models of a skeletal assemblage, they provide useful visual comparisons for skeletal element profiles which are routinely created in osteological recording of human skeletons, and which are used in the case studies examined in this research. They have been combined and numbered (Figure 16) in order to be more easily compared to the case study skeletal profiles and will be referred to in the thesis as profiles 1-6.

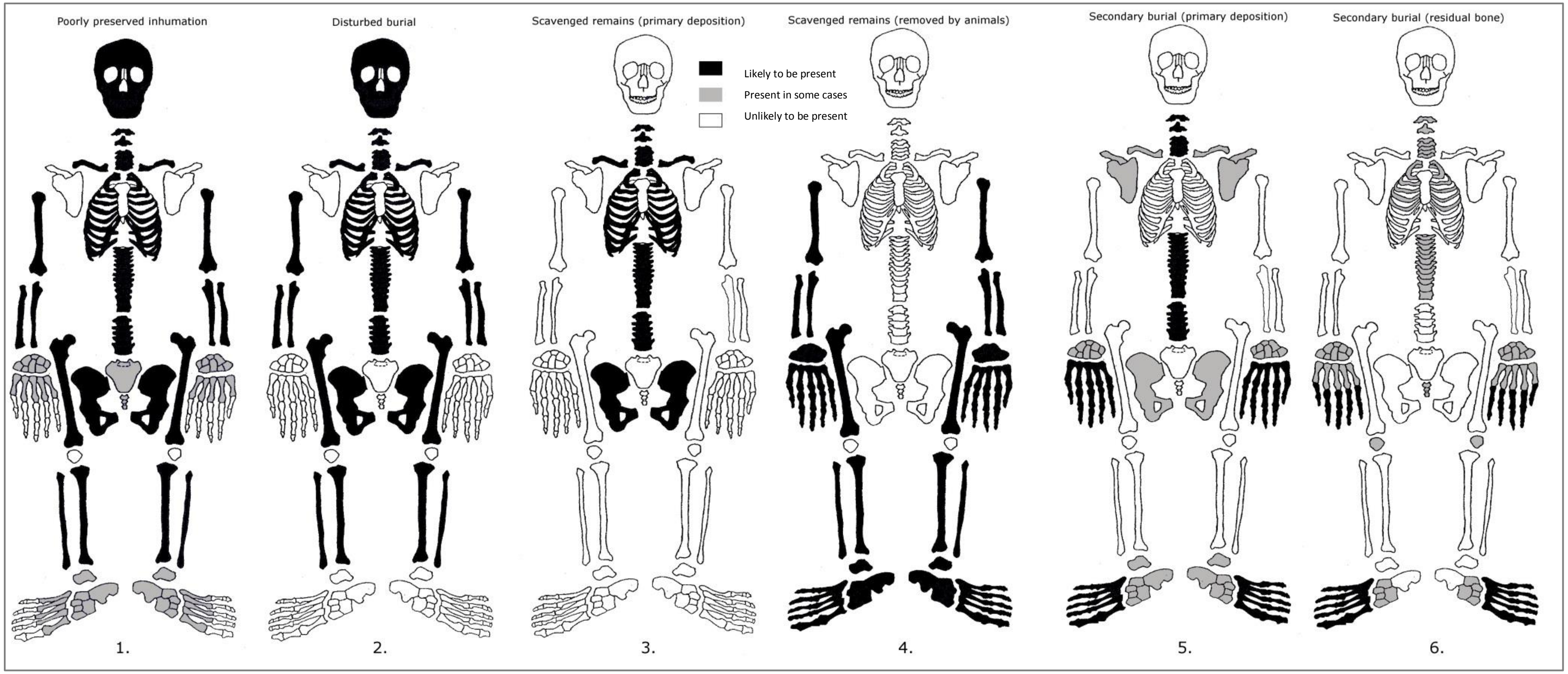


Figure 16: Combined skeletal element profiles for six possible taphonomic alterations; poorly preserved burial, disturbed burial, scavenged remains (primary deposit), scavenged remains (removed by animals), secondary burial (primary deposit), secondary burial (residual bone)

3.8 Disturbed inhumation burials

3.8.1 Farasan Islands case study

The following case study carried out primary analysis on the inhumation remains from Janaba Bay East in order assess a skeletal element profile from a likely articulated burial which had been truncated due to poor preservation conditions. It provides a test case for the distribution of skeletal elements that might be expected in a "disturbed" or poorly preserved burial within a shell midden and, along with the potential profile of a poorly preserved burial (Figure 12), can be used to test the assumption that disarticulated remains found in a shell midden are the result of a poorly preserved burial.

3.8.1.1 Janaba Bay East site

The Janaba Bay East site (JE 0004) is located on the Farasan Islands, Saudi Arabia and is one of 129 shell mounds which have been identified around the east bay (Meredith-Williams 2011, 119) (Figure 17). Fieldwork to investigate the cultural basis of the 3000 shell mounds on the Islands was conducted between 2006-2009 (Bailey et al. 2013b, 242) and included survey and excavation. The sites have not yet been fully published although there is a summary of the human remains found at Janaba Bay East included in the interim report (Bailey and Alsharekh 2011, 40).

Figure 17: Location of the Janaba Bay East site JE0004 (Meredith-Williams 2011, Figure 37). Also showing some of the other 129 shell mounds located on this stretch of shoreline

The shell midden showed two processes of accumulation of shells; the northern half of the site being used as a dumping zone while processing activities took place on the southern half of the site (Meredith-Williams 2011, 182). The burials are thought to be later insertions into the midden (Meredith-Williams 2011, 187).

3.8.1.2 Human remains at Janaba Bay East

The human remains in the Janaba JE0004 mound are poorly preserved and very friable. Some consolidation of the bones was conducted in situ in order to allow them to be lifted without disintegrating (Bailey and Alsharekh 2011, 40).

The human remains were found in the upper layers of the shell mound (Bailey and Alsharekh 2011, 40) after a section collapse revealed the bones (Meredith-Williams 2011, 187). Two distinct cuts, within which the human bones were placed, were identified and are thought to be two individual small pits or graves (Meredith-Williams 2015) (Figure 18). Radiocarbon dating has been conducted on the charcoal lining of the pit, and is thought to indicate that the burials are younger than the shell mound and therefore intrusions into it (Meredith-Williams 2011, 187).

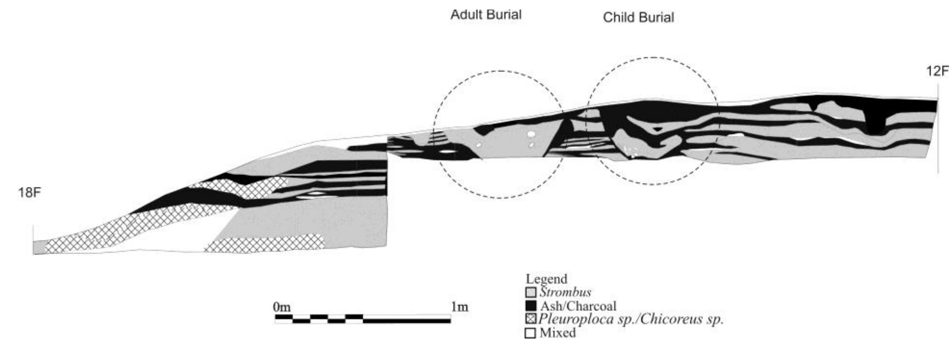


Figure 18: East facing section of JE0004 showing the grave cuts of the adult and juvenile burial (Section courtesy of M. Meredith-Williams, 2009 Southern Red Sea Project)

The first burial was located in a pit in grid squares 14FA-C (Figure 18) and contained a juvenile individual approximately 6 years of age (+/- 24 months) based on deciduous dentition and eruption of permanent dentition in a mandible (Buikstra and Ubelaker 1994, 51 Figure 24) (Figure 19).

Figure 19: Juvenile mandible 846a superior and lateral view. Showing dental eruption used for ageing.

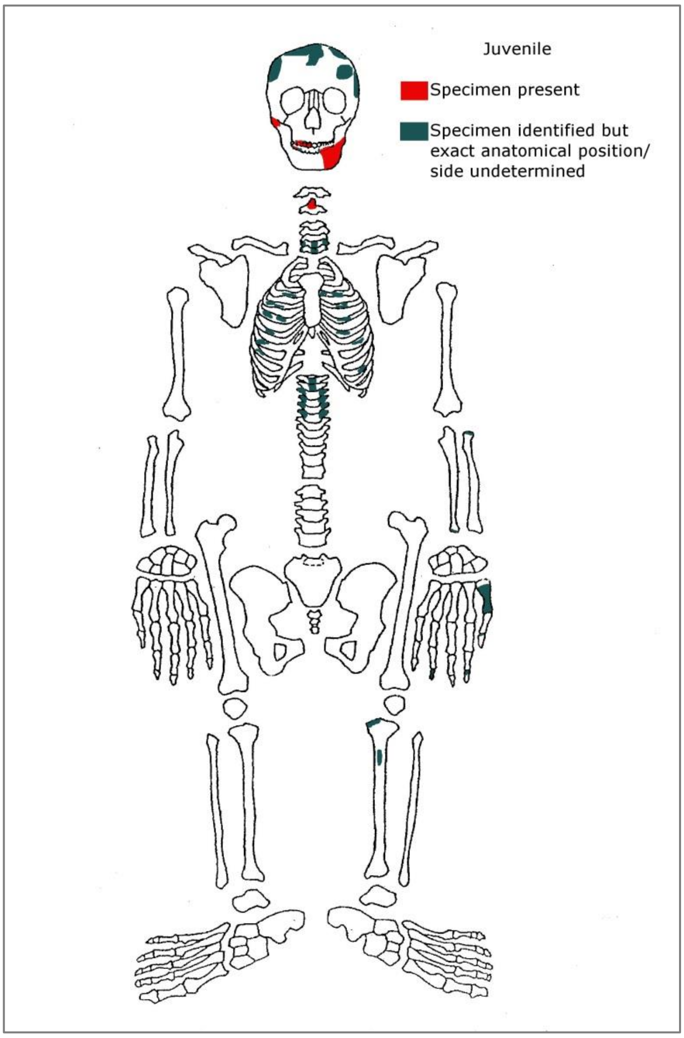


Figure 20: Skeletal element diagram of juvenile remains contained in pit 14FA-C at Janaba Bay East 0004

The juvenile remains (Figure 20) are described as a definitive burial within a cut which was lined with charcoal and contained a hammer stone and some unusual shells indicating that the grave was prepared for burial by burning and placement of important objects (Meredith-Williams 2011, 187-9). However, these remains are not securely attributed to an articulated inhumation burial due to the extremely poor level of preservation (Meredith-Williams 2015, pers. comm.). Owing to this lack of certainty about the original state of the juvenile human remains, they have been excluded from further discussion in the present study as they do not provide a secure case study for a disturbed inhumation.

Further human remains were found in a distinct pit cut containing ash located in grid square 15FA (Meredith-Williams 2011, 190) and are thought to be a partially articulated burial (Bailey 2015, pers. comm.; Meredith-Williams 2015, pers. comm.). At the time of excavation the anatomical position of tibia, fibula and foot bones were noted and photographed in situ (Meredith-Williams 2015, pers. comm.) (Figure 21, Figure 22 and Figure 23). The position of the legs and hands indicated that the adult individual was buried in an upright crouching position but given that the burial was found in the very upper part of the surviving midden it is likely that the upper part of the body had been truncated due to erosion of the top parts of the midden (Meredith-Williams 2011, 190).

Primary analysis conducted for this study confirmed that contained within the pit was up to 150 fragments of bone from the lower part of the body specifically from the left femur, tibia and fibula as well as bones from the left hand and foot (Figure 24) and a catalogue of the remains is provided in Appendix 2. Ageing and sexing on the human remains was limited by their poor preservation but it was possible to ascertain that the lower limb remains contained in the 15FA pit were likely to be adult remains although some were classified as of unknown age due to the lack of diagnostic elements contained within the assemblage; the pelvis and cranium were missing and the epiphyses of other bones were either absent or very fragmentary (Figure 24).

Figure 21: Photograph showing the articulated position of the foot bones from the adult individual at JE 0004 (Photo courtesy of H. Robson, 2009 Southern Red Sea Project)

Figure 22: Photograph showing the articulated position of the tibia and fibula bones from the adult individual at JE 0004 (Photo courtesy of H. Robson, 2009 Southern Red Sea Project)

Figure 23: Photograph showing the articulated dusty residue of finger bones at JE0004 (Photo courtesy of H. Robson, 2009 Southern Red Sea Project)

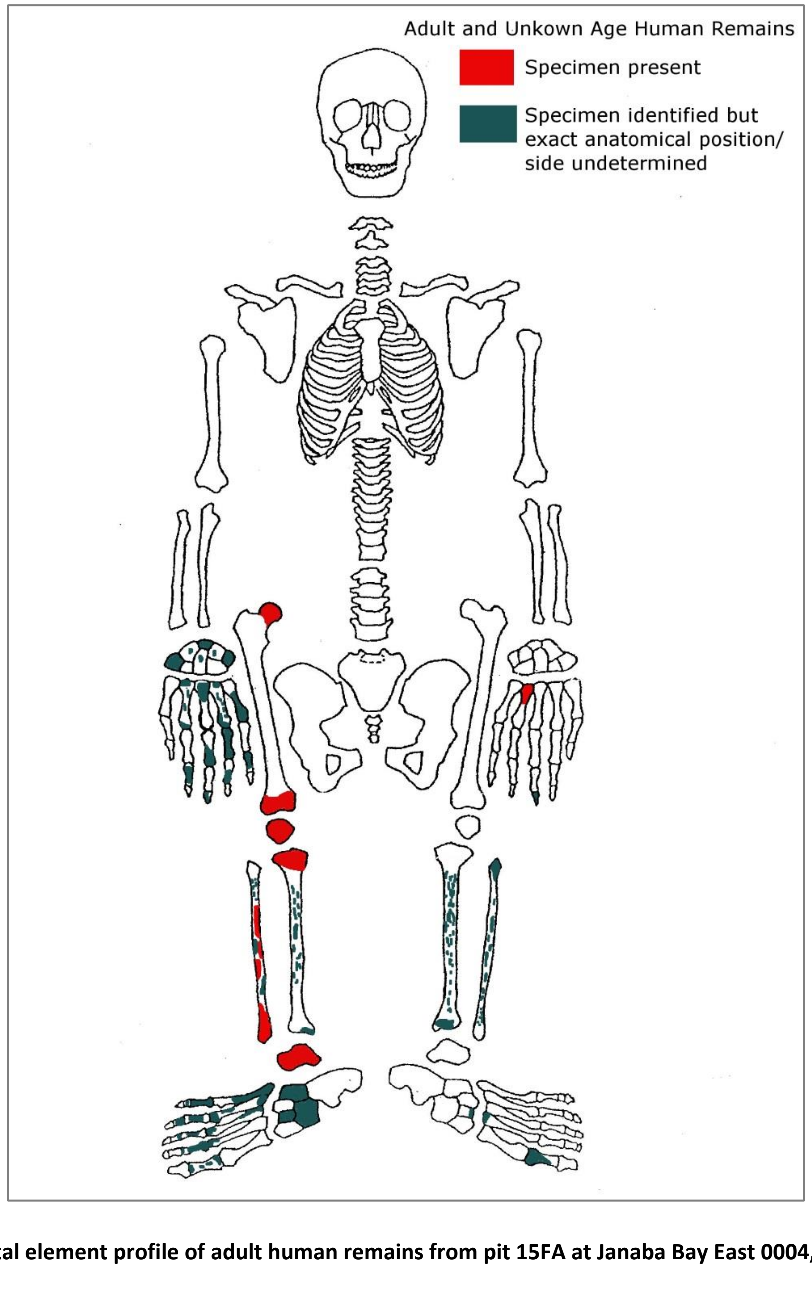


Figure 24: Skeletal element profile of adult human remains from pit 15FA at Janaba Bay East 0004, Farasan Islands

Supporting the field observations that this was originally an articulated inhumation it is notable that there is evidence, albeit very fragmentary, of most of the expected elements from the lower limbs of an individual in the assemblage (Table 7). This supports the expected pattern that poorly preserved inhumations would display fragments from most skeletal elements. The only missing element is the pelvis but it is likely that this has been lost with the other torso and upper body elements which were eroded.

Skeletal elements of lower limbs (including hands)	**Number of expected *whole* specimens in complete skeleton**	**Number of *fragments* identified in JE0004 assemblage**
Hands (x2): Carpals, metacarpals, phalanges	54	75
Pelvis	2	0
Long bones (x2 sides): Femur, tibia, fibula	6	152
Patella	2	1
Feet (x2): Tarsals, metatarsals, phalanges	50	58

Table 7: Table comparing the expected bones in the lower parts of a skeleton with the adult remains found at JE0004. Note a direct comparison cannot be drawn as the expected numbers are for whole bones but the identified bones at JE0004 are fragments and have not been corrected to account for over-representation of elements

Given the truncated nature of the adult remains, but the articulated position of the ones that do survive, it can be assumed that only the lower limbs and the distal parts of the upper limbs (ie. hands) remained within the midden by the time of discovery in 2006. The torso and pelvis, majority of the upper limbs and skull are likely to have been lost as the midden eroded over time. Therefore, the absence of these parts of the body is concluded as being part of non-human taphonomic loss due to weathering and site preservation processes.

The skeletal specimens that were recovered were extremely fragmentary; the maximum length of a fragment was only 7.28cm (from a distal shaft fragment of fibula) and the average length was 2.83cm (Figure 25).

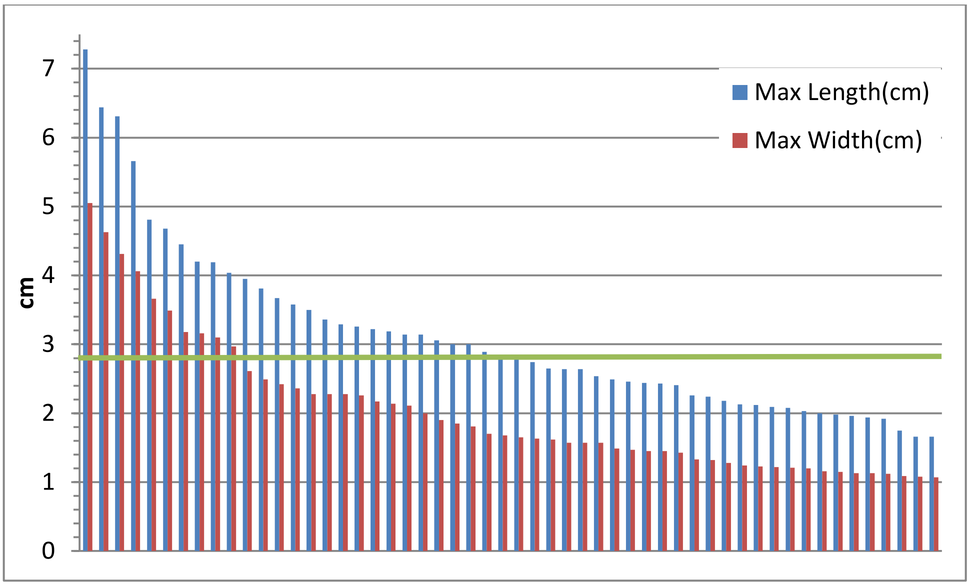


Figure 25: Chart showing the fragment size (maximum length and width) of adult bone specimens in Janaba 0004 midden. Green line shows average length of a fragment: 2.83cm

3.8.1.3 Pattern of preservation of a poorly preserved inhumation burial

The presence of smaller bones of the hands and feet alongside the normally well surviving bones like the femur (Figure 24) indicates that despite the poor condition of the bones the potential for survival in the midden exists. This adds support to the conclusion that the missing upper parts of the body are due to the erosion of the midden and not because of intentional selection or intrinsic factors of bone survival.

Intrinsic factors of decay suggest that more robust bones with a higher degree of cortical bone, such as the long bones, are more likely to survive in the archaeological assemblage (Mays 1992, 55). The pattern of preservation at Janaba 0004 shows that the long bones, whilst present, are subject to similar levels of decay and fragmentation as the smaller bones of the hands and feet. This is an important observation which has an impact on assessing the nature of interment into the shell midden. If a complete inhumation burial is placed into a shell midden, as is surmised about the Janaba remains, then it is likely that most of the bones will be represented in the recovered bone assemblage, albeit fragmentary in some cases. However, where entire elements are missing from the skeletal assemblage it is implied that some other factors are at play such as human funerary treatment removing bones, scavenging by animals or other active taphonomic processes which have removed parts of the body. These other possible taphonomic factors should be considered when there is evidence for missing skeletal elements before any assumptions are made about there being a "disturbed burial".

This case study suggests that it is possible to identify a disturbed inhumation in a shell midden. Knowledge of the site taphonomy and careful observation of the human remains in situ can be combined with analysis of the presence of skeletal elements to conclude whether the missing bones are likely to have been lost through deliberate human action (funerary practices) or through non-human taphonomic factors.

3.8.2 Carding Mill Bay cist burial case study

3.8.2.1 Location and excavation

The Carding Mill Bay site is located near to Oban in Scotland (Figure 26) and was discovered in 1990 during construction work involving the mechanical removal of scree from the foot of the cliff (Connock 1990). The presence of an archaeological site was recognised when a large quantity of shells and a juvenile human mandible were discovered at the cliff face (Connock et al. 1992, 25). A rescue excavation followed with the main objective of recording and removing the human bone (Connock et al. 1992, 25).

The site consists of two main elements; a shell midden within a V-shaped fissure in the cliff face and a later, and now fragmentary, cist burial (Connock et al. 1992). Human remains were discovered in both the cist and the shell midden as well as some remains being found adhering to the cliff face in the fissure itself (Connock 1990).

The cist burial, contexts II and III, consisted of partially articulated human bone lying partly within the cliff fissure on undisturbed sandstone slabs. Some of the sandstone slabs also covered the human remains. The sandstone most likely originated in the cliffs below the site and are not thought to have fallen from the adjacent cliff onto the site as this cliff is formed of conglomerate rock (Connock et al. 1992, 25). The incomplete nature of the skeletal remains and cracking of the stone slabs indicated that the cist had been disturbed, but lack of fresh fractures on the slabs led to the conclusion that the disturbance was not recent (Connock 1990). It was thought that scree slope processes may have displaced the cist and its contents (Connock et al. 1992, 25).

Here, discussion will focus on the cist burial remains in order to investigate the pattern of preservation of a disturbed inhumation burial. However, analysis of the human remains contained in the fissure and shell midden contexts at Carding Mill Bay is undertaken as part of a later case study in this thesis.

3.8.2.2 Date of cist burial

A small flint and sherd of a food vessel of the type commonly found within inhumations and cremations during the Bronze Age were used to date the cist burial to the mid-second millennium BC (Connock 1990; Connock et al. 1992, 29). No radiocarbon dates have been obtained on the human bone contained within the cist burial.

Figure 26: Location of the Carding Mill Bay shell midden site, Scotland

Initial interpretations of the stratigraphy and burials at the site (Connock 1990; Connock et al. 1992) suggested that the cist burial was distinct from the earlier midden deposit which was again distinct from the fissure deposit, each representing a discrete burial phase. The contextual information provided by the pottery sherd in the cist means that it is reasonable to assume that the cist burial is later than the other burial deposits at the site and indeed belongs to a Bronze Age burial.

3.8.2.3 Human remains in the Carding Mill Bay Cist burial

Given the accepted Bronze Age date of the cist burial it can be assumed that the bodies buried here were complete inhumation burials, as was the predominant custom during that time (Brück 2004, 308-9) and leads to the assumption that the body was interred in a completely articulated and fleshed state. The site report details that some of the bones in the cist showed "a degree of articulation" (Connock et al. 1992, 25) further supporting the argument that the burial was originally an articulated inhumation. Given this likelihood, it is therefore possible to assess the pattern of preservation in the cist burial with reference to the potential skeletal profile of a disturbed burial presented in 3.7.2 above. It is particularly pertinent in this case as the cist is found on the same site, and in close proximity to, a shell midden which also contained human remains making the pattern of preservation of this disturbed burial all the more important for comparison to the other burial remains in the main Carding Mill Bay case study.

The original site report concluded that the cist burial contained two individuals; one adult and one juvenile (Connock et al. 1992) and this is supported by the cataloguing of the bones from Glasgow museum, carried out for this thesis. Ageing and sexing conducted on the remains for this research study concluded that it was not possible to securely ascribe the sex of either individual as there were no diagnostic elements surviving. The original bone report did postulate that the adult remains might be female (Lorimer 1991) but there is no explanation of how this conclusion was reached. Presumably the sexing was based on the size of the bones but this is not a reliable indicator for sexing; preferred techniques use the range of sexual dimorphism displayed in the pelvis and skull (White and Folkens 2005, 387-398).

Area of body	Number of individual specimens present (NISP)	Proportion of cist assemblage
Skull	2	4.5%
Vertebrae	9	20.5%
Rib cage	19	43.2%
Upper limbs	7	15.9%
Lower limbs	5	11.4%
Extremities	2	4.5%
Total	**44**	**100%**

Table 8: Summary of skeletal specimens present in the cist burial at Carding Mill Bay

The human remains found within the cist burial (Table 8 and Figure 27) are consistent with examples of primary inhumation burials. There is a low proportion of tarsals, carpals and other extremities and it is known that these bones are often lost from the record through preservational or recovery factors (Cox and Bell 1999, 945; Henderson 1987; Nawrocki 1995, 62;

Waldron 1987). The presence of long bones in the cist burial is also consistent with the preservation that would be expected in a whole body interment (Merbs 1997); these dense bones have survived well, while other less dense bone has not survived.

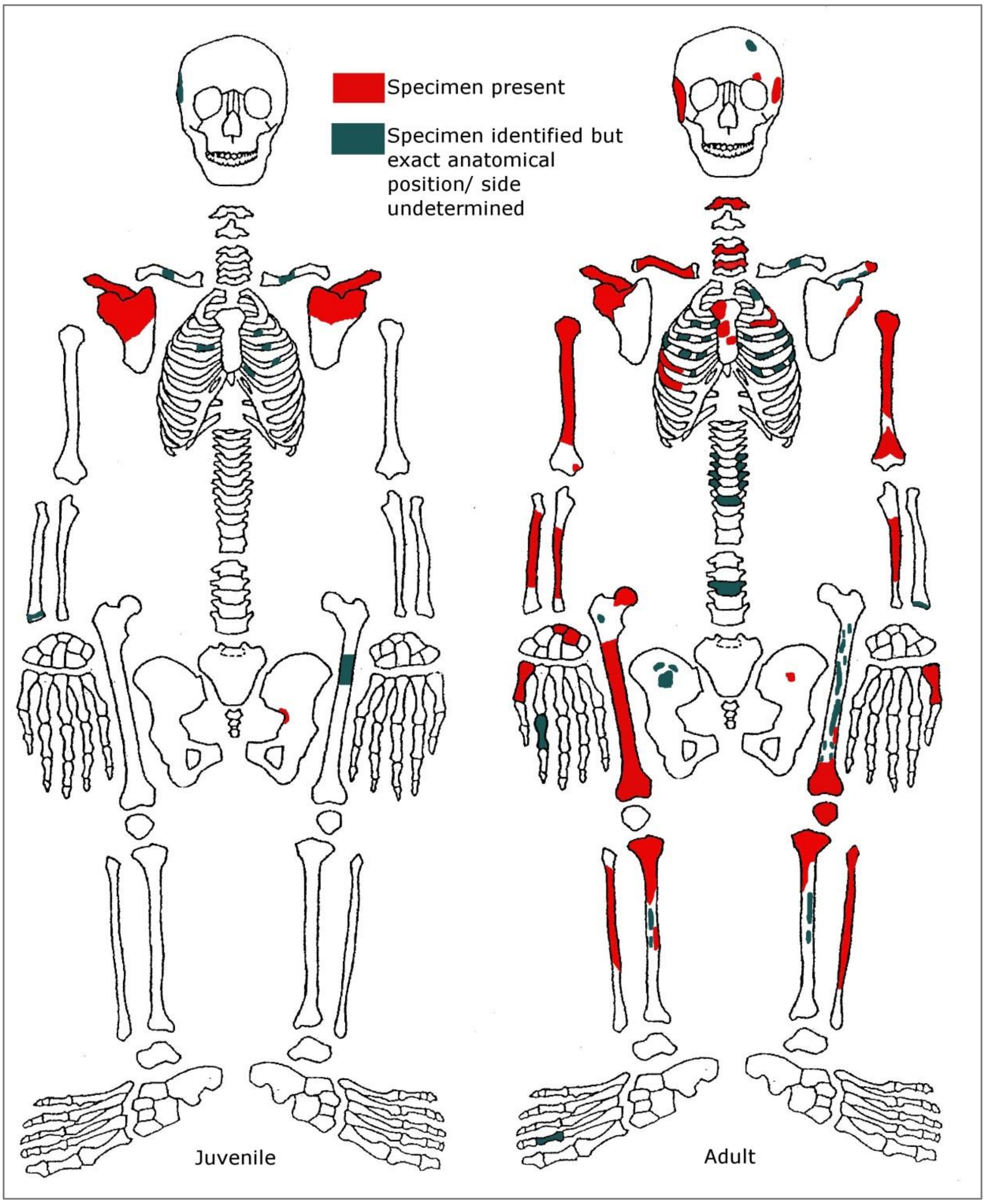


Figure 27: Skeletal element profile of two individuals in the cist burial context at Carding Mill Bay

The observed pattern of remains at Carding Mill Bay is consistent with profile 2, the potential skeletal profile of a disturbed burial (Figure 28), as most areas of the skeleton are represented but more robust elements are favoured. The articulation observed during excavation is also what would be expected from a disturbed burial as well as the likelihood of disturbance at the site.

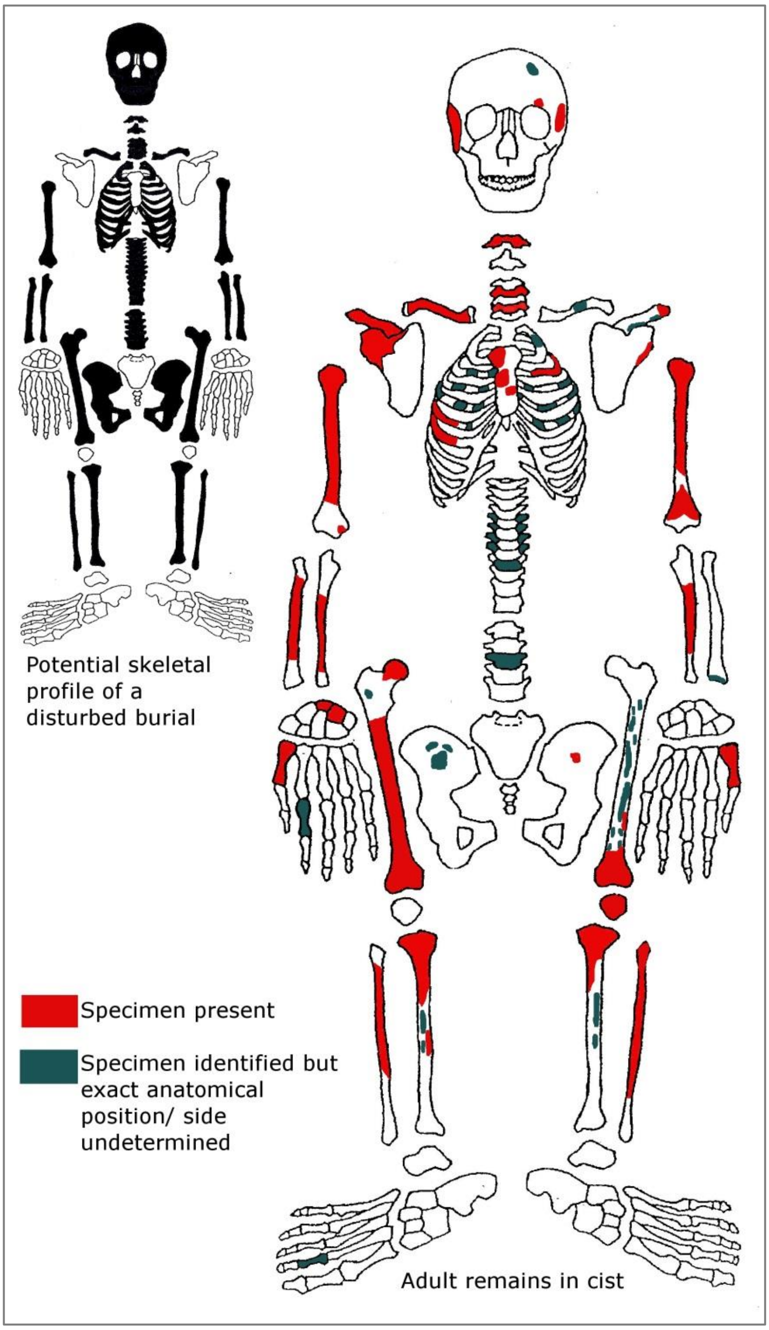


Figure 28: Comparison of the adult remains in the cist at Carding Mill Bay with the profile number 2, a disturbed burial

By combining knowledge of the predominant burial practices at the time with comparison to survival patterns the cist burial at Carding Mill Bay demonstrates that the pattern of preservation of a known disturbed burial is consistent with that which is expected given the intrinsic survival of bone identified through preservation studies.

3.9 Conclusion

Ethnographic observations of burial customs demonstrate the wide variety of interactions and processes which societies have with their dead. Far from being unusual, there is often a close involvement with the decomposition processes of the cadaver linked to beliefs about the transition of the person from this life into the next through liminal stages. The integrity of the body and completeness of the skeleton is not always a concern even though the funerary treatment is considered and ritualistic in nature. These examples serve to demonstrate that the disarticulated human remains found in shell middens may well have originated from an intentional human practice which broke up the body.

Knowledge of potential taphonomic factors that might affect assemblages of human bone provides a means to analyse the disarticulated bones found on a shell midden. The human taphonomic factors of primary and secondary burial have been discussed, showing that human action can either keep the body intact or intentionally skeletonise and break up the body. Intentional disarticulation of the corpse can result in cutmarks, and obvious selection or removal of particular parts of the body. Additionally, the evidence for processing the body might imply some form of cannibalistic activity, but this is much harder to prove. Evidence of extensive burning to the bone causing warping and discolouration is consistent with cremation practices but smaller scale charring might be evidence of other funerary processing or possibly cooking of the bone.

Non-human taphonomic factors which affect bone assemblages have also been discussed. Decomposition mechanisms inform the understanding of the intrinsic pattern of survival of bones, where the more robust and larger skeletal elements are more likely to survive in the archaeological record. Shell midden environments have the potential to buck trends of other archaeological sites where small elements from the extremities, like phalanges and metacarpals, are often missing. The morphology of the shells means that they may act as an “umbrella” like structure filtering water away from these small bones and making them more likely to survive.

Other non-human taphonomic factors which have the potential to affect human bone assemblages have also been discussed. Disarticulation patterns of mammals provide a proxy for human remains and suggest that the body becomes disassociated in a known pattern. Knowledge of this pattern can be used to assess the skeletal elements present on a site to determine whether an entire body was originally placed there or if parts of the body had been brought to the site in a partially (or wholly) disarticulated state.

Additionally, non-human agents such as scavenging animals can have an effect on the disarticulation process of the body and these also produce predictable patterns of deposition.

Finally, sub-aerial weathering processes can affect the bones, causing cracking and bleaching which would be distinctive evidence of prolonged excarnation of the skeletonised remains. However, short-term excarnation and weathering would have a less obvious impact on the bones.

The investigation of these human and non-human taphonomic factors affecting burial remains has enabled a series of potential skeletal profiles, 1-6, to be drawn, illustrating the expected skeletal elements present in six different taphonomic examples. These profiles will act as comparative examples for consideration of assemblages of disarticulated human remains in shell middens in the following chapters.

Chapter Four: Carding Mill Bay

4.1 Introduction

Carding Mill Bay is a small shell midden site located near to Oban on the western coast of Scotland (Figure 29). The site lies at the base of a conglomerate rock cliff and was covered by scree up to 3m high (Connock 1990, 74; Connock et al. 1992, 25). The archaeological site was first discovered during removal of this scree as part of building work to make space for housing, the results of which were published in the early 1990's (Connock 1990; Connock et al. 1992; Connock et al. 1991). A large accumulation of shells drew attention to the possibility of archaeological material being present but unfortunately there had already been some truncation of the site with the removal of large amounts of scree and its use for infill on the building site (Connock 1990, 74).

A juvenile mandible was discovered adhering to the cliff face and further human bone was seen lying on the surface of the undisturbed material. A rescue excavation was subsequently carried out with the main aim of recording and removing the human bone (Connock et al. 1992, 25). The research showed a complex stratigraphy with a shell midden and human bones dating to the Early Neolithic, as well as the insertion of a Bronze Age cist burial. The research has been published in a short report (Connock et al. 1992) and the human bones have also been analysed for dietary isotopic study (Schulting and Richards 2002) but otherwise the human bones have not been studied.

The shell midden context of the site, with the inclusion of human remains, provided an excellent potential case study for this thesis. This chapter presents the background to the excavation, the examination of the human bones which was undertaken at Glasgow Museum, and the analysis of burial practices displayed at the site in relation to taphonomy and the six potential profiles, as set out in Chapter 3.

4.2 Carding Mill Bay site description

The main archaeological deposits lay at the bottom of the cliff with most of the undisturbed material lying within a material lying within a natural v-shaped fissure as well as lying between some thin sandstone slabs (Connock 1990, slabs (Connock 1990, 74; Connock et al. 1992, 25). Within the sandstone slabs was some partially articulated human articulated human bone and a small piece of Bronze Age flint and a rim sherd of Bronze Age pottery (Connock 1990, pottery (Connock 1990, 74) (

Figure 30). The human bone contained within the sandstone slabs was identified as a Bronze Age cist burial (as described in Chapter 3).

Figure 29: Location of Carding Mill Bay shell midden, Scotland

Below the level of the cist burial was a shell midden made up of two distinct layers of limpet shell separated by a thin separated by a thin layer of finely crushed shell. Worked bone and antler artefacts (identified as limpet scoops), limpet scoops), chipped stone (mainly quartz) and some perforated cowrie shells were found in the shell midden the shell midden layers along with some human remains (Connock et al. 1992, 25-9) (

Figure 30). Further human remains were also found directly below, but seemingly unrelated to, the cist burial and within the cliff fissure.

There are five main contexts which contained human remains at Carding Mill Bay; the cist burial, an unspecified midden deposit lying directly below the cist burial, two shell midden layers (one earlier shell midden and one later shell midden) separated by a thin layer of crushed shell, and finally the cliff fissure itself (Table 9). These contexts have been coloured on the harris matrix and section profile diagram to aid identification of the five distinct contexts which produced human remains (Figure 31).

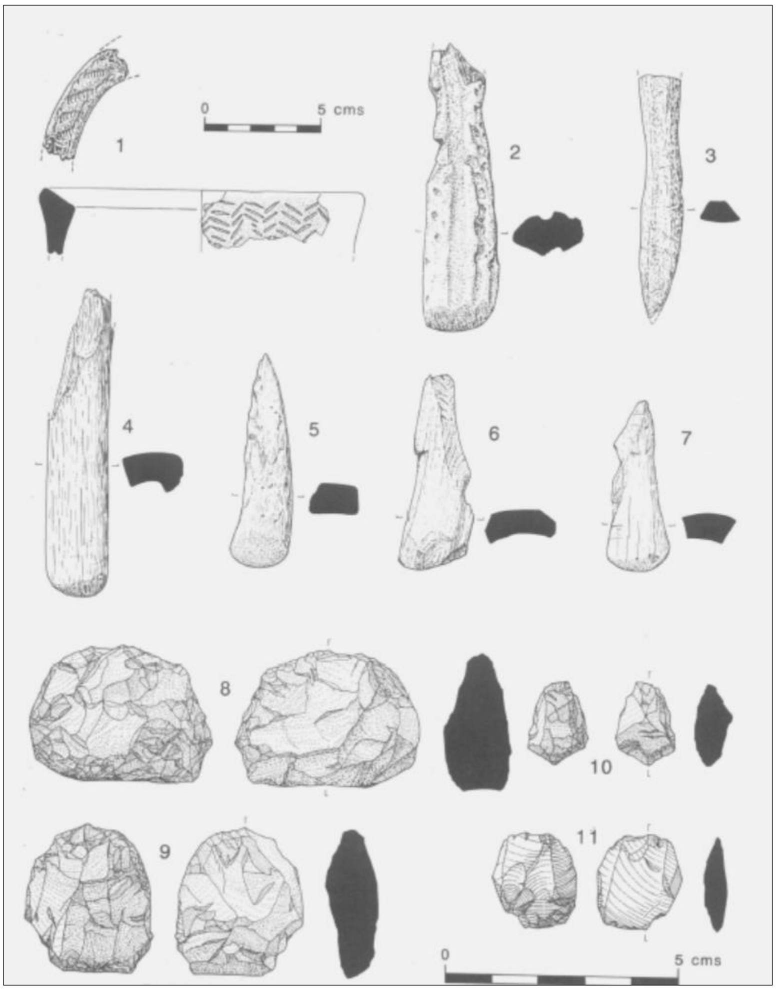


Figure 30: Artefacts from Carding Mill Bay (after Connock et al. 1992, Figure 3). 1: Bronze Age pottery, 2-7: Antler, 8-11: Quartz

Context numbers	Name attributed to context for purpose of this study	Context description (from Connock et al. 1992, Table 1)
I	N/A	Unstratified material
II and III	Cist burial	Inhumation and cist
IV	Unspecified midden	Layer below III, containing some human bone
VII, VIII	N/A	Soil against rock face
VII, IX, XIII, XIV, XV, XVI, XVII	Earlier shell midden	Shell midden (early)
X, XI, XII	Later shell midden	Shell midden material adhering to rock face (later shell midden)
XVIII	N/A	Black soil
V, XIX-XXIV	Fissure	Fissure deposits

Table 9: Summary of contexts at Carding Mill Bay

4.2.1 Cist burial context

The cist burial remains, discussed in Chapter 3, were located in contexts II and III at the site (Figure 31) and were contained within thin sandstone slabs which had been deliberately brought to the burial site, rather than having fallen from the adjacent cliff (Connock et al. 1992, 25).

4.2.2 Unspecified midden context

Below the level of the sandstone slabs, in contexts IV and XII (Table 9 and Figure 31), were more partially articulated human bones but these are thought to be unrelated to the cist burial and instead represent an earlier inhumation (Connock 1990; Connock et al. 1992). There is no description of these contexts available except that they are the layers below III and are an unspecified midden deposit (Connock et al. 1992; Lorimer 1991) (Figure 31). The site description (Connock et al. 1992, 25-8) does not specifically mention context XII but it is present on the harris matrix diagram (Figure 31) and from this appears to be part of the unspecified midden, along with context IV. The human bone report describes the layer as "immediately below the cist stones of layer III and above the main shell midden" (Lorimer 1991, 4). The field descriptions of the contexts in the archived fiche record of the site (Connock et al. 1991), which is held by Historic Scotland, describe context IV as "brown earth" and context XII as "a thin mixed layer" (Connock et al. 1991). Hence, although these layers have been named "midden", they are distinct, and probably unrelated to the *shell* midden layers. The unspecified midden context is therefore defined as contexts IV and XII for the purposes of this study and dealt with separately to both the shell midden layers which it overlies and the cist burial that it is beneath. This context will be referred to as *unspecified midden* deposits.

4.2.3 Earlier and later shell midden contexts

Two separate shell middens were identified during the course of excavation and have been termed the *earlier shell midden* and *later shell midden.* The later shell midden (contexts XI and X Table 9 and Figure 31) was found adhering to the south eastern face of the cliff and at a higher level than the earlier shell midden layers (Connock et al. 1991). It was a layer of tightly compacted shells some of which (context X) had been affected by calcium carbonate accretions and was described as a later phase of the earlier shell midden (Connock et al. 1991) which contained only a "small quantity of human bone and teeth" (Connock et al. 1992, 28).

The earlier shell midden layers (contexts VII, IX, XIII, XIV, XV, XVI, XVII, Table 9 and Figure 31), underlying the skeletal remains in the unspecified midden, were largely comprised (between 85-92% by weight) of limpet shells with charcoal stained soil (Connock 1990; Connock et al. 1992). The shell midden layer was up to 25cm thick and was made up of two distinct layers which were separated by a thin layer of crushed shell (Connock 1990) (Figure 31). The upper portion of the midden was more tightly packed and contained less charcoal but more stones than the lower level (Connock et al. 1992, 28) and were dealt with as two distinct layers by the excavators; contexts XIII and XV (Connock et al. 1992, 28) (Table 9 and Figure 31) but are both are still considered part of the earlier shell midden.

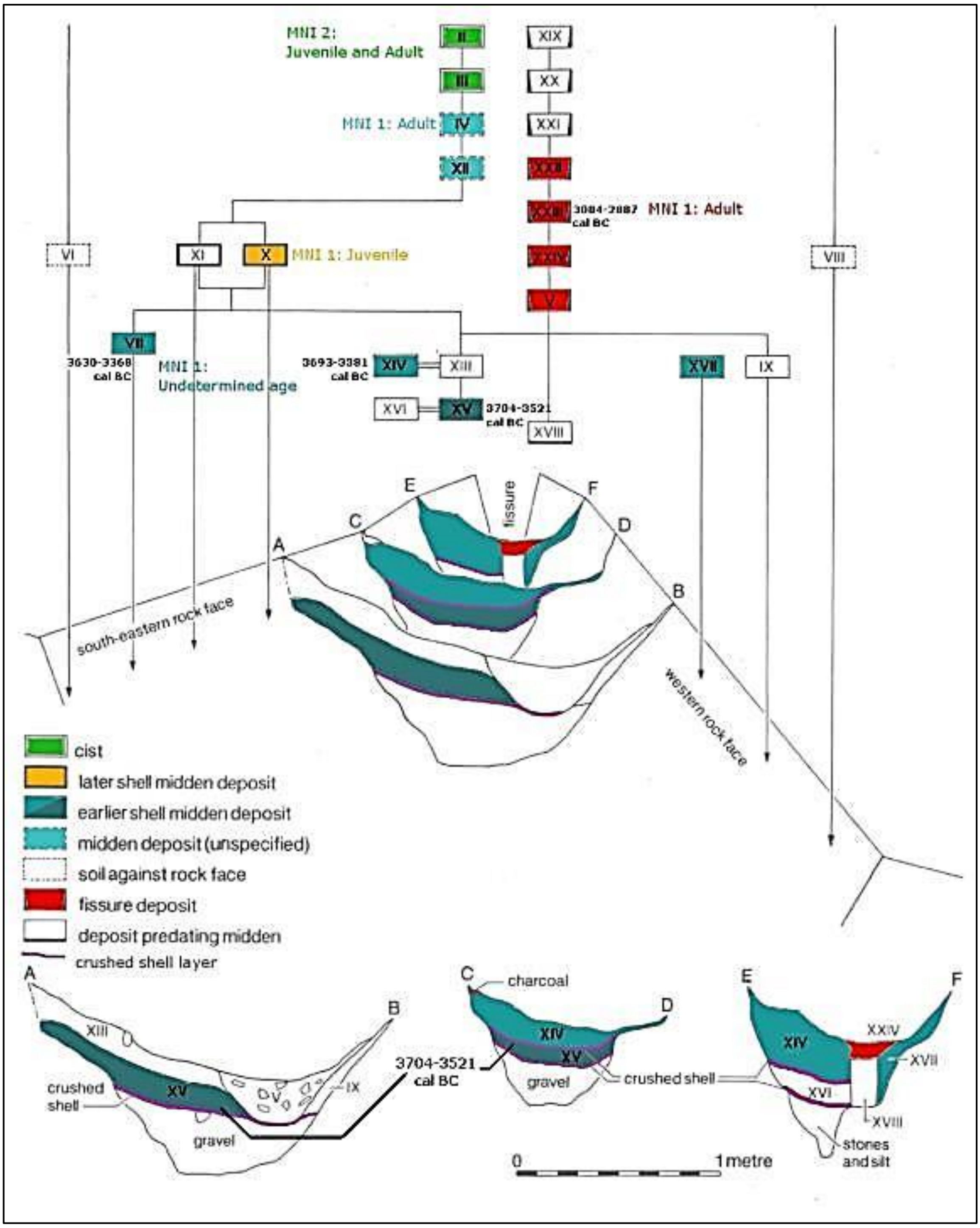


Figure 31: Sections and harris matrix diagram of contexts at Carding Mill Bay, coloured contexts indicate presence of human remains. (Diagram after Connock et al. 1992, Fig. 2; Dates after Schulting and Richards 2002 and recalibrated for this study)

Within the earlier shell midden there were a large number of bone and antler artefacts found. These have been These have been described as bevel ended 'limpet scoops' which are commonly found in Obanian shell midden sites shell midden sites (Connock et al. 1992). Also present in the earlier shell midden was a number of worked quartz worked quartz fragments (

Figure 30) and some perforated shells also consistent with the 'Obanian' (Connock et al. 1992).

Description of the earlier shell midden also refers to “a few isolated human bones” which are found within layers likely to pre-date the cist (Connock et al. 1992, 29). The original study concluded that there was no convincing evidence for there being intact burials with shell midden deposits and that the presence of the cist burials above the midden contexts was “purely co-incidental” (Connock et al. 1992, 30).

4.2.4 Fissure context

Within the cliff fissure (contexts XXIII, XXIV, V, Table 9 and Figure 31) there were few significant finds except for some further partially articulated human remains (Connock 1990) which were identified as a later disturbed burial. Non-human bone finds in the fissure were attributed to later carnivore activity at the site (Connock et al. 1992, 28) which of course could also account for the inclusion of the disarticulated human bone, particularly in the fissure context. However, close clustering of dates on charcoal and shell samples obtained by Connock et al. from the earlier shell midden layers was sufficient to lead them to conclude that the early midden material had not been disturbed in this way (Connock et al. 1992, 28-31).

4.3 Dating of Carding Mill Bay site

Connock et al. (1992, 30) obtained radiocarbon dates on two charcoal samples from the earlier shell midden. There have been two further radiocarbon dates taken on bone and antler tools (Bonsall and Smith 1992) and four radiocarbon dates obtained on human bone (Schulting and Richards 2002), all of which have been recalibrated for this study (Table 10).

The cist burial has not been subjected to radiocarbon dating but the stratigraphy and associated finds strongly imply a date in the Bronze Age (Connock 1990; Connock et al. 1992). One date was obtained on a human metatarsus from the fissure context (Table 10 and Figure 32) and this demonstrates that the fissure context represents a later burial episode, 3084-2887 cal BC, which corroborates with the stratigraphy of the site.

The dates obtained on shells, charcoal and bone and antler tools (Table 10 and Figure 32) from the midden layers show that this is most probably an early Neolithic shell midden with calibrated dates ranging from c. 4,000BC to c. 3,500BC, although the types of dates obtained and the relatively small number might call into question whether there is slightly earlier, late Mesolithic, occupation of the site (Milner and Craig 2009, 174). It is clear however that the human remains found within the midden contexts are of definitive Neolithic date, ranging from c. 3,700BC to c. 3,300BC (Table 10 and Figure 32).

No dates have been obtained on either the later shell midden or the unspecified midden. However, human bones from these contexts were tested by Schulting and Richards (2002) during their dietary isotope analysis. The results for the individuals in both the later shell midden context and the unspecified shell midden are within the same terrestrial range as those from the individual in the earlier shell midden (Table 10) indicating that they shared a similar diet, although it is not possible to say that they are therefore contemporary deposits.

Although it would be preferable to date more than one bone from the fissure deposit to be sure that the later date is consistent amongst all of the bones, further dates are not available at this time. As a result, the following analysis assumes that the human remains contained within the fissure deposit constitute a later addition to the site, with the human bones found within the earlier shell midden context being representative of a single phase of deposition, due to the calibrated dates overlying each other. The later shell midden context is dealt with as a related but probably later episode than the earlier shell midden, based on their stratigraphic relationship.

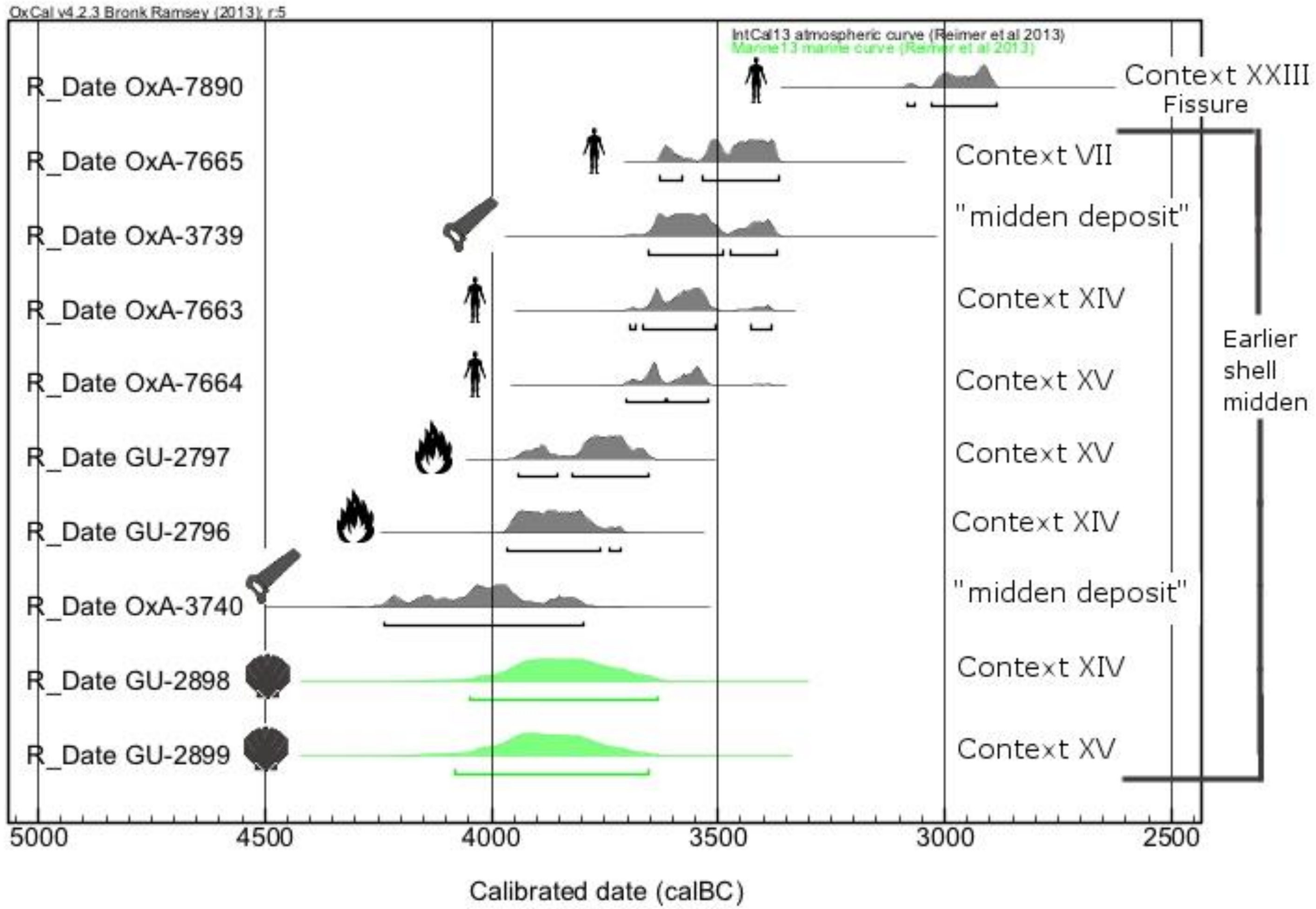


Figure 32: Plot of calibrated radiocarbon dates from Carding Mill Bay. Calibrations are new, using OxCal 4.2 (Bronk Ramsey and Lee 2013) and IntCal 13 calibration curve (Reimer et al. 2013). The two shell dates have been calibrated using the marine curve Marine 13 (Reimer et al. 2013) with a Δ^R correction of -16 +/- 75 calculated using the marine correction database (Stuiver et al. 2010)

Lab code	Sample number	Context	Material	δ C13	Radiocarbon BP	2 sigma cal BC	Source
OxA-7890	A.1997.10.ga	Fissure (XXIII)	human metatarsus	-21.4	4330 $^{+}/_{-}$ 40	3084-2887	(Schulting and Richards 2002)
OxA-7665	A.1997.10.ga	Earlier shell midden (VII: 130)	human parietal	-21.5	4690 $^{+}/_{-}$ 40	3630-3368	(Schulting and Richards 2002)
OxA-3739		"midden deposit"	bone tool		4765 +/- 65	3656-3372	(Bonsall and Smith 1992)
OxA-7663	A.1997.10.dm	Earlier shell midden (XIV: 1)	human phalanx	-21.5	4800 $^{+}/_{-}$ 50	3693-3381	(Schulting and Richards 2002)
OxA-7664	A.1997.10.dn	Earlier shell midden (XV: 1)	human metacarpal	-21.0	4830 $^{+}/_{-}$ 45	3704-3521	(Schulting and Richards 2002)
GU-2797		Earlier shell midden (XV)	charcoal		4980 +/- 50	3942-3653	(Connock et al. 1992)
GU-2796		Earlier shell midden (XIV)	charcoal		5060 +/- 50	3965-3714	(Connock et al. 1992)
OxA-3740		"midden deposit"	antler tool		5190 +/- 85	4236-3796	(Bonsall and Smith 1992)
GU-2898		Earlier shell midden (XIV)	shell		5410 +/- 60	4049-3632	(Connock et al. 1992)
GU-2899		Earlier shell midden (XV)	shell		5440 +/- 50	4082-3654	(Connock et al. 1992)

Table 10: Radiocarbon dates at Carding Mill Bay. Calibrations are new, using OxCal 4.2 (Bronk Ramsey and Lee 2013) and IntCal 13 calibration curve (Reimer et al. 2013). The two shell dates have been calibrated using the marine curve Marine 13 (Reimer et al. 2013) with a Δ^{R} correction of -16 +/- 75 calculated using the marine correction database (Stuiver et al. 2010)

4.4 Existing work on the human remains

A summary of the original human bone report is available in the site report (Connock et al. 1992) and the full text of the human bone report by Daphne Lorimer (1991) is available in the archived fiche of the published site report (Connock et al. 1991), obtained for the purposes of this study from the Royal Commission for Ancient and Historical Monuments of Scotland's archive.

Lorimer concluded that a minimum number of 5 individuals were buried at the site (Connock et al. 1992); the presence of three first cervical vertebrae (atlas) were used to determine that at least 3 adult individuals were represented and a juvenile mandible, whose tooth development was indicative of a child aged around 2 years old, indicated a fourth individual (Connock et al. 1992). The fifth individual, an older juvenile aged approximately 10-11 years, was identified by the root closure of loose teeth and the presence of juvenile scapulae (Connock et al. 1992).

Tentative sexing and ageing of the adult remains was provided in the report which attributes the remains found in the cist burial as a female aged between 30-35 years and in the fissure deposit was a male individual, aged between 17-23 years old (Connock et al. 1992, 29). It is not clear how the ageing and sexing of the female was carried out but the male individual was identified from the size of the atlas bone and the morphology of a mandible also found within the same context and aged presumably based on the tooth wear analysis. It should be noted however that the size of a bone is not a reliable indicator for sexing, and preferred techniques use the range of sexual dimorphism displayed in the pelvis and skull (White and Folkens 2005, 387-398).

The report noted little evidence of pathology present on the skeletal remains. There were degenerative changes on the cervical vertebrae, osteophyte formation (indicative of degenerative joint disease, DJD) present on two thoracic vertebrae and reactive bone tissue on a femur and caries on seven out of forty permanent teeth and calculus on ten (Connock et al. 1992).

4.5 New analysis of the human remains

New primary analysis of the human remains was conducted for this research during a visit to Glasgow Museums Resource Centre (GMRC) in October 2011. The analysis which follows is based on this primary analysis combined with the original inventory and skeletal diagrams (Lorimer 1991).

4.5.1 Collection available for study

The human skeletal assemblage from Carding Mill Bay is large, comprising well over 100 individual skeletal specimens, although the exact number of elements is dependent on whether you count every individual fragment of bone or not. A comprehensive inventory of the human remains is provided in Appendix 3 and a summary is given in Table 12.

Primary analysis was carried out on the previously identified human remains, where it was possible to identify these in the collection. By going through all bags it was possible to identify some human remains which had not been classified as human on the GMRC catalogue entries. These specimens are listed in Appendix 3. It has not been possible to ascertain whether these bones have previously been identified as human and misclassified in the records or if these have been identified for the first time. Some, such as A.1997.10.df was a femur sampled for isotopes by Schulting and Richards (2002) and had obviously been recognised as human at this time.

It was not possible to view several bones during the visit to GMRC because they were not available for study at that time. It has been possible to refer to photographs kindly supplied by Jane Flint of GMRC for several of the missing bones although some have not been viewed at all. Appendix 3 summarises which bones have been viewed only via photographs and which have not been seen at all, as well as providing details of bones which have not been analysed because they were removed from the collection for study by other researchers.

In Lorimer's report (1991) she details specimens from the unspecified midden context XII. Other than this mention of these remains, there is no other trace of these remains in any of the published material dealing with Carding Mill Bay. These specimens were not present in the GMRC collection examined as part of this study and at this time the location of these specimens is unclear. They have however been included in this new skeletal analysis as the human bone report contains general identification of skeletal elements from this context (Lorimer 1991, 4) and the fiche skeletal diagrams and inventory further identify the remains (Connock et al. 1991). They have therefore been dealt with alongside the other specimens from the unspecified midden.

Where skeletal identification was achieved for missing specimens they have been included in the analysis, see Appendix . Specimens which are simply listed as "bone" cannot be further identified at this stage and have therefore been excluded from the following analysis.

A number of the human remains from the earlier shell midden were not viewed as part of this study because either their current whereabouts was unknown or they had been destroyed for isotope analysis (Schulting and Richards 2002). However, they still contribute to the skeletal element analysis as by combining Lorimer's inventory (1991) with the descriptions of Schulting and Richards (2002) it is possible to securely identify the missing elements (Appendix).

The same is true of the later shell midden, where a non-adult scapula was unavailable for study as it had been destroyed for isotope analysis (Schulting and Richards 2002). The human bone report states that it was a juvenile left scapula which appeared to be approximately 10-11 years of age. Loose human teeth belonging to a juvenile in the later shell midden, are mentioned in the site report (Connock et al. 1992, 29) but these were not available for study during the research trip to the GMRC. Lorimer's report states that there were 7 permanent teeth, none of which had closed roots, thus originating from a juvenile aged between 10-11 years (Lorimer 1991, 3), and therefore likely to belong to the same individual as the left scapula. Also detailed in the full human bone report (Lorimer 1991, 3) but not included in the published material (Connock et al. 1992) or seen during the research visit to GMRC, are 8 rib shaft fragments from a child, a fragment of juvenile pelvis and 1 adult rib fragment.

4.5.2 Age and sex

Ageing and sexing carried out for this study provided no secure ageing of either individual skeleton in the cist burial context due to the fragmentary nature of the remains. None of the specimens found in the unspecified midden contexts appear to be non-adult but again the fragmentary nature of the remains prevented any secure ageing. All of the remains contained within the fissure contexts appear to be adult with the exception of the juvenile thoracic vertebra and rib fragments mentioned by Lorimer (1991, 4).

Given the fact that a number of the remains from the earlier shell midden are no longer available to study it was not possible to provide confident ageing or sexing of the remains in this context for this study. However the specimens that were seen appear to be adult due to epiphyseal fusion. In the later shell midden a juvenile aged 2-3 years is represented by a mandible (Figure 33 and Figure 34) based on the stages of eruption of deciduous premolars and molars (Buikstra and Ubelaker 1994, Fig. 24). A further juvenile aged between 10-11 years is identified from the missing non-adult scapula (Lorimer 1991, 3) and 7 permanent teeth none of which had closed roots (Lorimer 1991, 3).

Figure 33: Juvenile mandible A1997.10.dh from right lateral view, showing the eruption of deciduous premolars.

Figure 34: Juvenile mandible A1997.10.dh from superior view showing the eruption of deciduous premolars and the presence but non-eruption of deciduous molars.

4.5.3 Minimum number of individuals

The ageing and sexing of the remains, combined with the repeated occurrence of the 1st cervical vertebrae (atlas) in 3 contexts provides an MNI of 7 for this study (Table 11). There are two individuals in the cist burial; one adult (including an atlas vertebra) and one juvenile (Connock et al. 1992). The unspecified midden contains at least one individual which is definitely distinct from other contexts at the site because it contains an atlas vertebra. In the fissure another atlas vertebra signifies a further distinct adult individual and in addition to juvenile remains in this context, results in the conclusion that the fissure contains at least two individuals. However, although the adult remains in the fissure are distinct and therefore contribute to the site MNI the juvenile remains cannot be securely identified as distinct from the other juvenile remains at the site due to lack of repeated elements and therefore cannot count towards the site MNI.

In the earlier shell midden there is a MNI of one individual as there are no repeated skeletal elements and no clear evidence of differing ages within the context. This earlier shell midden context is dated earlier than the fissure remains (Figure 32 and Table 10) and is likely to be distinct from the unspecified midden and cist burial due to the stratigraphical position. Therefore, the individual contained in the earlier shell midden is presumed to be distinct and contributes to the MNI for the site.

Context	MNI for context	Cumulative MNI for site
Cist	2 (1 adult, inc. atlas; 1 juvenile)	2
Unspecified midden	1 (1 adult, inc. atlas)	3
Fissure	2 (1 adult, inc. atlas; 1 juvenile)	4 (juvenile not distinct)
Later shell midden	3 (1 adult; 1 juvenile, aged 2-3 years; 1 juvenile aged 10-11 years)	7
Earlier shell midden	1 (no repeated elements or differing ageing)	7 (cannot separate adult from later and earlier shell midden)

Table 11: Summary of the MNI's in each context at Carding Mill Bay and how they contribute to site MNI

Likewise, the remains in the later shell midden are thought to be distinct from the fissure, unspecified midden and cist but cannot be separated from the earlier shell midden deposits. However, the later shell midden does have an MNI of three based on the ageing of the remains; one juvenile aged 2-3 years, one juvenile aged 10-11 years, and one adult, specific age unknown.

The adult remains from the later shell midden cannot be securely identified as distinct from those in the earlier shell midden and therefore the MNI of 3 from the later shell midden only contributes 2 individuals to the site MNI of 7.

4.5.4 Pathology

No new pathologies in addition to the DJD, reactive tissue and caries noted in the original human bone report (Lorimer 1991) were observed during the analysis for this research.

4.5.5 Taphonomic indicators

One of the specimens found in the fissure contexts has animal gnaw marks present. The first right metatarsal (A1997.10.dc) has crushing on the lateral side near the base (Figure 35) which is consistent with animal gnawing (for example see Binford 1981, 45-8; Buikstra and Ubelaker 1994, 100 Figure 69a; Haglund 1997). The presence of animal gnawing is not unexpected as the site report notes that the presence of non-human bone from the burial phase could relate to carnivore activity given the disturbed nature of the deposit (Connock et al. 1992, 28). The evidence that animal gnawing did affect at least one of the human skeletal specimens means that it should be considered as a realistic taphonomic factor affecting the human remains at this site, specifically in the fissure context.

Figure 35: Right- 1st right metatarsal A1997.10.dc showing crushing caused by canine gnawing on the lateral side near the base.

4.5.6 Skeletal elements present

Bone survival at Carding Mill Bay is good and there is a significant assemblage of human remains, a number of which are in a very good state of preservation, particularly those found in the fissure deposits and cist burial. The good preservation indicates that the conditions at the site were conducive to bone survival and that perhaps the lack of some skeletal elements is a result of a process other than poor preservation. A summary of the human remains in each context is provided in Table 12 and skeletal profile diagrams of all remains is provided in Figure 36 and Figure 37.

Context	Skull	Vertebrae	Rib cage	Upper limbs	Lower limbs	Extremities
Cist	2	9	19	7	5	2
Fissure	3	9	3	4	4	6
Unspecified midden	7	8	20	1	5	4
Later shell midden	10	0	9	1	1	0
Earlier shell midden	2	1	0	0	0	5

Table 12: Summary of human remains found at Carding Mill Bay

The report states that fissure layers contained little significant material except for human bone, specifically a mandible and four articulated vertebrae with long bones and skull being notably absent (Connock et al. 1992, 28). Some fragmentary long bones have now been identified (see Appendix 3) which were perhaps long bone fragments originally mistaken for animal bone.

Vertebral specimens from the unspecified midden were found in a semi-articulated state and were therefore assumed to represent an inhumation burial (Connock et al. 1992). The bone report also lists three fragments of skull bone, one fragment of left maxilla, one fragment of left frontal and two teeth being found in the unspecified midden (Lorimer 1991, 4).

Ten skeletal specimens were found in the earlier shell midden deposits. Six of these were from the extremities, two from the skull, one from the upper limb and one from the vertebral column. A metacarpal fragment and ulna fragment are known only from the human bone report (Lorimer 1991), and no further mention of them has been found in the published literature.

The known skeletal specimens which were found in the later shell midden deposit are listed in Appendix 3 and summarised in Table 12, but only one skeletal specimen, a juvenile mandible was viewed as part of this study.

The skeletal element profile diagrams (Figure 36 and Figure 37) demonstrate that there is a considerable difference between the types of specimens found within each context at Carding Mill Bay. The first consideration for interpreting this difference has to be whether the archaeological assemblage is complete. In the case of Carding Mill Bay, it is impossible to say if any deposits were lost during building clearance of the site, but the fact that when human bone was identified in a large deposit of shells the building work stopped and archaeologists were called in (Connock 1990, 74) suggests that had there been any identifiable human bone removed it would have been noticed. The uncertainty surrounding this aspect of the assemblage is common to archaeological sites and must be taken into account during the interpretation, but should not inhibit interpretations from being drawn.

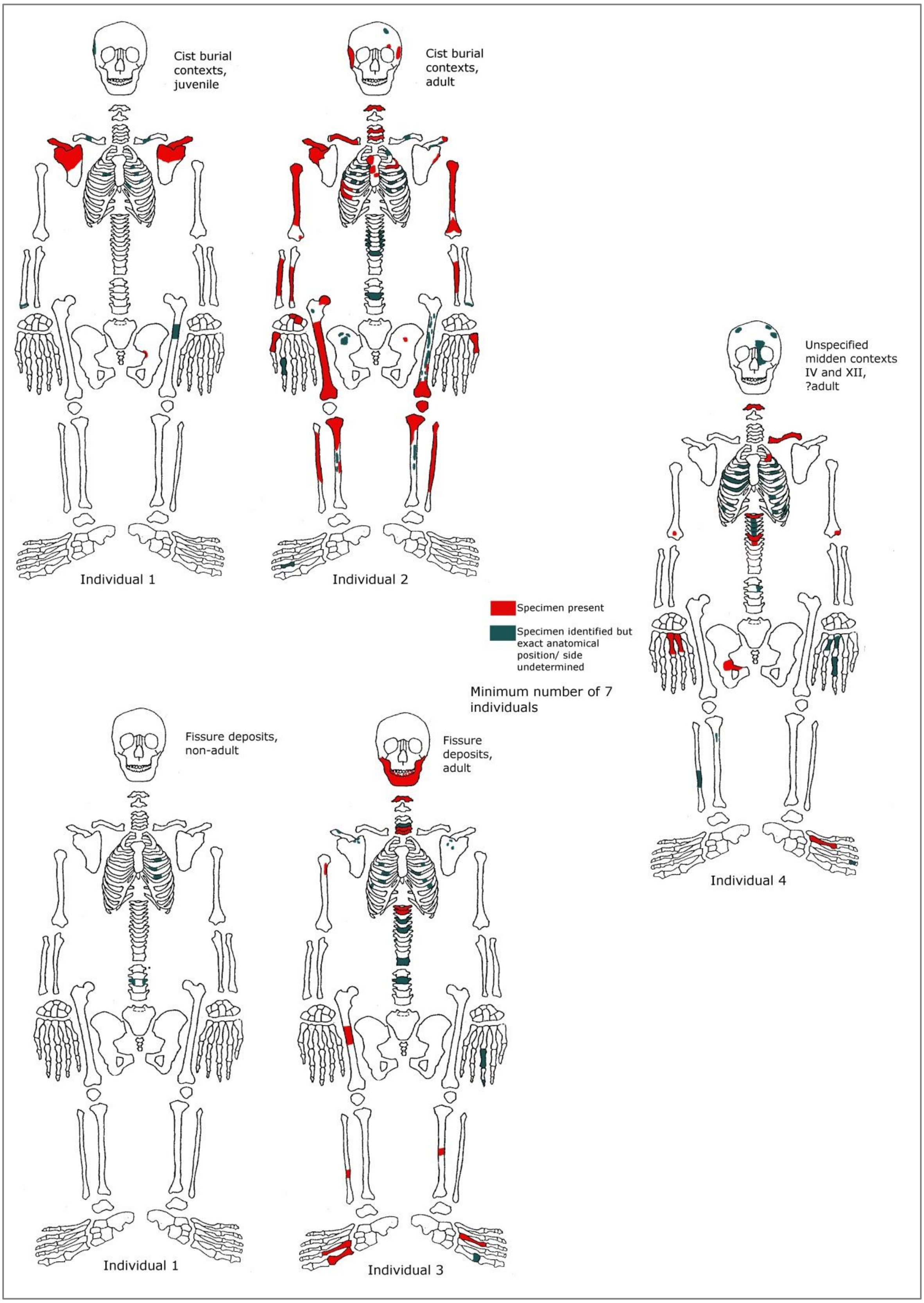


Figure 36: Skeletal inventory diagram of human bone specimens in non-shell midden contexts at Carding Mill Bay

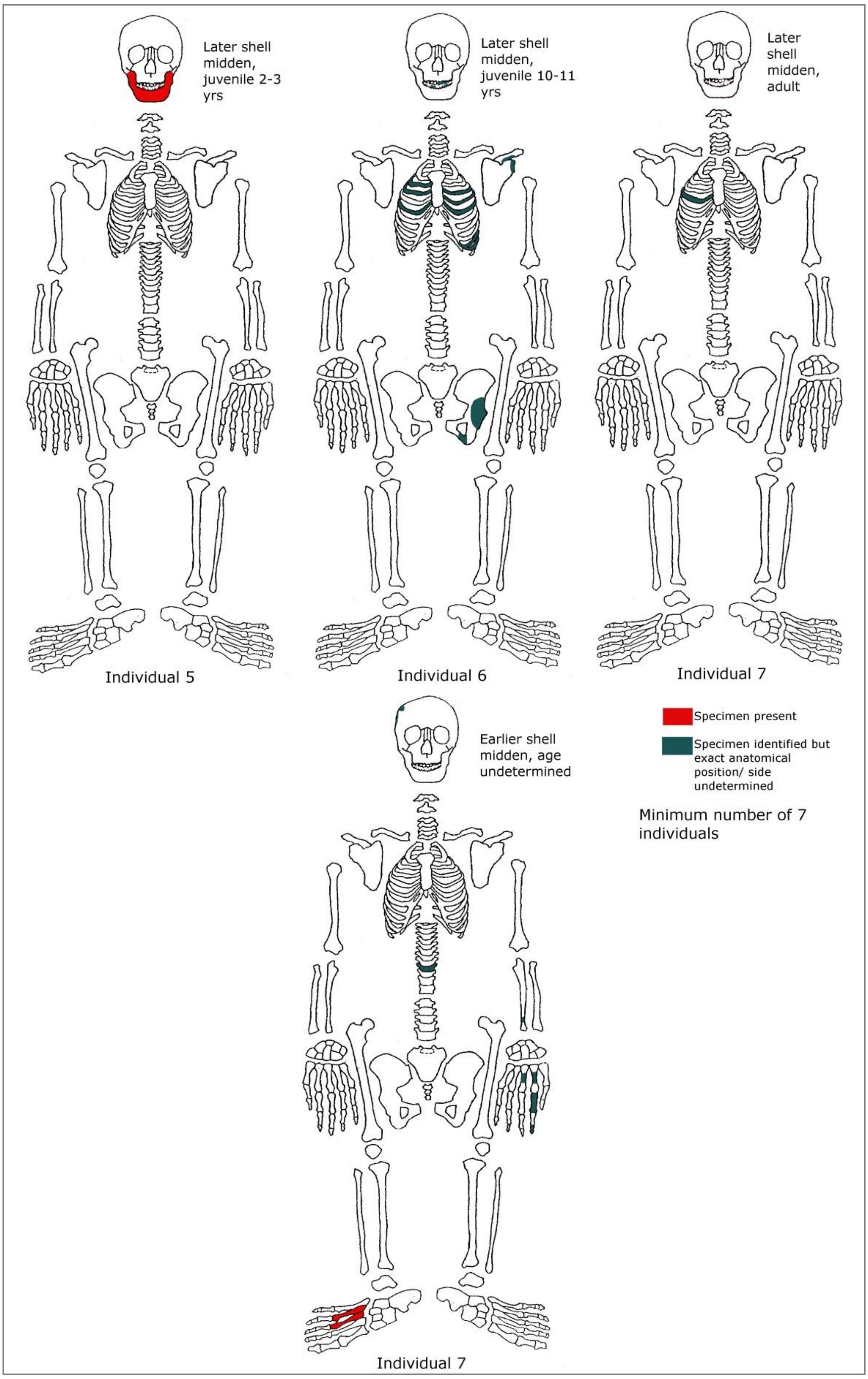


Figure 37: Skeletal inventory diagram of human remains in shell midden contexts at Carding Mill Bay

4.5.7 Chi-squared comparisons of the disturbed cist burial and other human remains

As was demonstrated in Chapter 3 the cist burial remains closely match profile 2, a disturbed inhumation burial. Therefore, the Carding Mill Bay site provides a unique opportunity to compare a known disturbed inhumation burial with the disarticulated and fragmentary remains from a shell midden. The close proximity of these remains on the same site and in largely the same preservation conditions, makes such a comparison all the more relevant.

Chi-square tests for goodness of fit were carried out comparing the cist burial with the other contexts at Carding Mill Bay. These calculations are detailed in Appendix 4 and summarised in Table 13. At all three p values the null hypothesis can be rejected in both the earlier shell midden context and the unspecified midden, meaning that the skeletal specimens in these contexts are not the same as, and therefore *do* differ significantly from, the skeletal specimens in the cist context.

	$X^2{}_c$	df	p=0.05	p=0.02	p=0.01
Fissure	10.71	5	H0 not rejected	H0 not rejected	H0 not rejected
Unspecified midden	22.05	5	H0 rejected	H0 rejected	H0 rejected
Later shell midden	7.53	5	H0 not rejected	H0 not rejected	H0 not rejected
Earlier shell midden	46.52	5	H0 rejected	H0 rejected	H0 rejected

Table 13: Results summary comparing the skeletal element distribution between the cist context and other contexts at Carding Mill Bay using chi-square analysis. Where the null hypothesis is rejected it is assumed that the burial practices differ significantly from those of a complete inhumation burial as present in the cist

The rejection of the null hypothesis for the comparison between the unspecified midden and cist burial suggests that it does not constitute a disturbed inhumation burial because it is statistically different from the cist burial. However, the skeletal element profile diagrams (Figure 38) suggests that the remains from both the burial in the cist and the unspecified midden deposit are the result of a complete articulated body being placed at the site due to the presence of articulated vertebrae. The ribs and vertebrae are the last parts of a skeleton to disarticulate and therefore the presence of articulated vertebral sections in both the cist burial and the unspecified midden indicates that it is likely that a complete body was present in these contexts and remained there with little enough disturbance to keep the articulation of some of the spinal column.

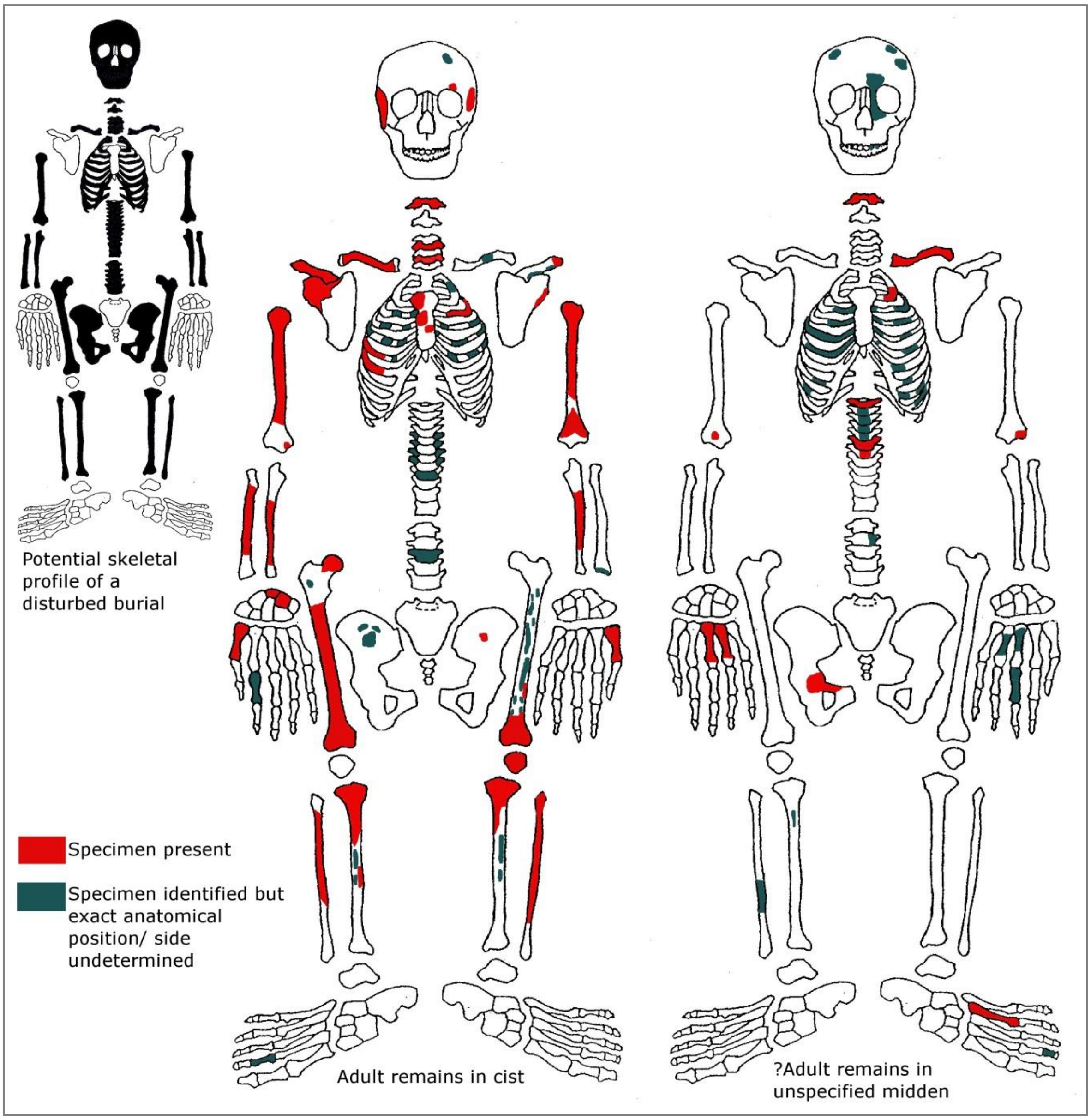


Figure 38: Comparison between skeletal element profiles from the cist burial and unspecified midden context at Carding Mill Bay also showing the potential skeletal profile of a disturbed burial

Tarsals and metatarsals are amongst the later bones to become disarticulated from the skeleton and are expected to survive well due to their dense nature. However the skeletal element profiles (Figure 38) of the cist burial and the unspecified midden show a complete lack of tarsals and only one metatarsal present in both contexts. The missing tarsals, carpals and other extremities from the cist and unspecified midden contexts is consistent with archaeological examples of primary inhumation burials (Cox and Bell 1999, 945; Henderson 1987; Nawrocki 1995, 62; Waldron 1987) where these elements are often missing.

Nevertheless, the cist and unspecified midden deposit are statistically different, implying that they do represent different taphonomic histories. It is likely that both are examples of primary inhumation burials but that perhaps the body in the unspecified midden was subject to some secondary processing of the remains. The main difference between the two contexts appears to be the lack of long bones associated with the unspecified midden (Figure 38). These would be expected to survive well as they contain high proportions of cortical bone (Mays 1992, 57) and their good survival has been demonstrated by Ubelaker in his study of ossuary remains from North America (Ubelaker 2002, Table 18.3). Comparison of the skeletal element profile of the cist burial and the potential profile of a disturbed burial with the profile of the undisturbed midden (Figure 38), highlights the difference between these two contexts at Carding Mill Bay. The unspecified midden does not look comparable to the disturbed burial potential profile whereas the cist burial is very closely aligned. Perhaps the lack of long bones present in the unspecified midden is due to collection of these bones as a secondary funerary rite.

The articulation of some portions of the skeleton in the unspecified midden, suggest that an articulated body was once at the site but the missing long bones imply a secondary burial rite. Therefore, comparison between the profile 5, a secondary burial, and the unspecified midden profile is necessary. Such comparison is provided in Figure 39 and the similarities are apparent, with the presence of vertebrae, metacarpals and metatarsals and phalanges. It seems likely that the human remains in the unspecified midden context are evidence of a site of primary deposition of the body before secondary funerary processing removed selected skeletal elements, specifically the long bones.

The chi-squared analysis also showed that the human remains in the earlier shell midden differed significantly from the disturbed cist burial. Further chi-square analysis was then conducted to test whether there is a statistically significant difference between the skeletal elements in the unspecified midden and the earlier shell midden (Appendix 4). The null hypothesis was that there was no difference between the skeletal element frequencies in the unspecified midden and the earlier shell midden, and the results are summarised in Table 14.

	X^2_c	df	p=0.05	p=0.02	p=0.01
Earlier shell midden	30.71	5	H0 rejected	H0 rejected	H0 rejected

Table 14: Results summary comparing the skeletal element distribution between the unspecified midden and the earlier shell midden at Carding Mill Bay using chi-square analysis. Where the null hypothesis is rejected it is assumed that the skeletal elements differ significantly between the two contexts

The null hypothesis can be rejected at all three p values and suggests that the unspecified midden and earlier shell midden are significantly different and therefore are likely to have resulted from different funerary practices. Comparison of the two inventory diagrams (Figure 36 and Figure 37) suggests that the unspecified midden contains a greater range of different parts of the body than the earlier shell midden. The pattern of skeletal specimens in the earlier shell midden suggests a very different taphonomic history than that in the unspecified midden and much more complex than a single event, primary inhumation burial. The specimens in this context are so sparse, but each is largely complete, implying that survival of the bone is good and that selection of the remains caused such a small proportion of the skeleton to become deposited in the midden.

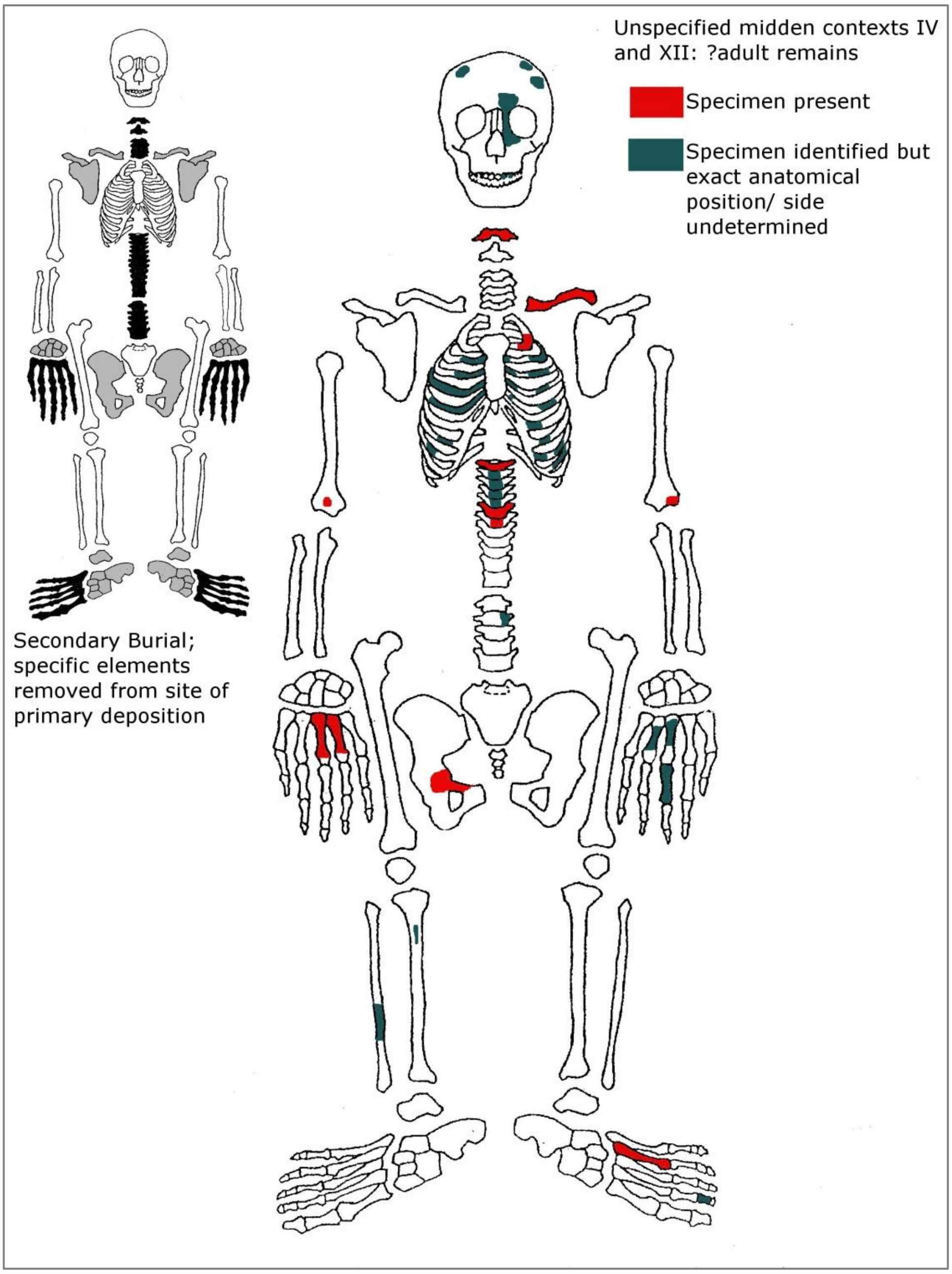


Figure 39: Comparison between unspecified midden skeletal element profile and the potential skeletal profile of a primary site of secondary burial

The remains in the earlier shell midden are not consistent with animal scavenging due to lack of trunk bones and long bones. There is no evidence for weathering on the specimens from the earlier shell midden making it unlikely that the body was simply exposed on the midden and left to decay with no further human intervention. The elements which survive are largely from the extremities, which is not an expected prevalence given the intrinsic survival of bone. The most convincing interpretation of these remains, given the lack of explanation provided by non-human taphonomic processes, is that these remains were incorporated into the midden as residual elements from a multi-stage funerary process. The small elements are likely to be missed when de-fleshed and disarticulated bone is collected for secondary treatment, and it is known ethnographically that it is not always important for all bones to be collected. The skeletal profile of the earlier shell midden is most comparable with the profile 6, a secondary burial where only residual bone remains (Figure 40).

The remains in the later shell midden are very incomplete but show a different pattern to the earlier shell midden, with fewer extremities and more torso elements, which perhaps accounts for why the later shell midden does not differ significantly from the cist burial. However, the scarcity of the remains, despite the site being conducive to good bone survival, means that the later shell midden assemblage could be the result of similar practices to the earlier shell midden, where most skeletal elements were removed from the site for secondary rites leaving a few fragmentary remains behind in the midden.

Comparison of the skeletal element profile of the later shell midden with profile 6, a secondary burial where residual bone remains (Figure 41), shows that there are some similarities between these profiles. The most notable difference is that the later shell midden contains no evidence of extremities, which would be expected in a secondary burial scenario.

However, when the profile 3, a scavenged burial, is compared with the later shell midden (Figure 41) there seems to be more in common between these profiles. The absence of animal gnaw marks on the remains from the later shell midden does not mean that these are not the result of animal scavenging as the vertebral column, from which most of the specimens in the later shell midden originate, is not a part of the skeleton that would be intensively targeted by gnawing as there is not a high meat yield compared to other parts of the skeleton.

A case for scavenged remains is also provided by the skeletal profile of the fissure context. The chi-square analysis shows that the fissure deposits do not differ significantly from the cist burial. However, the articulated vertebral fragments found in the fissure context and the pattern of remains, largely from the trunk with few long bones, seems to be comparable to scavenged remains (Figure 42).

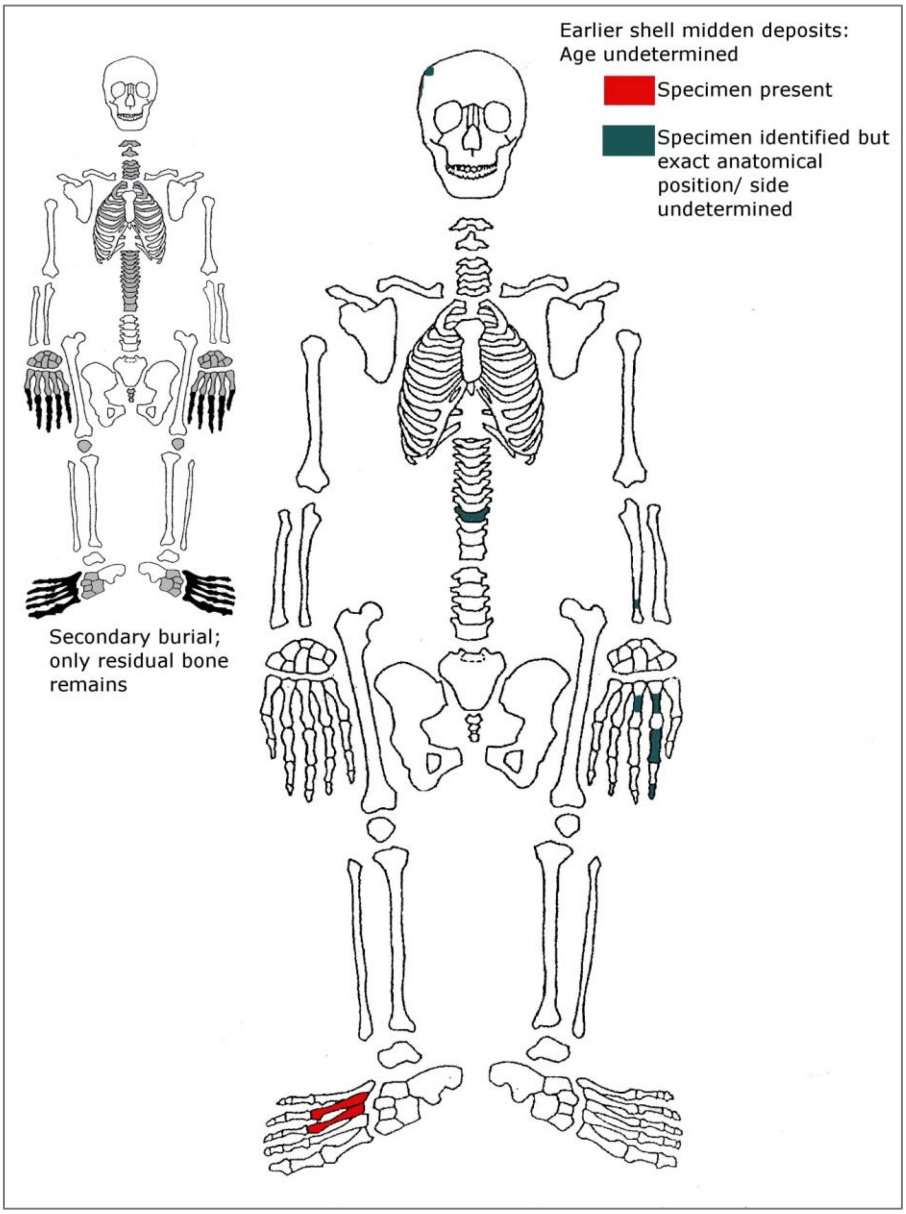


Figure 40: Comparison of the skeletal element profile of the human remains from the earlier shell midden at Carding Mill Bay and the potential profile of a secondary burial where only the residual bone remains

The animal gnawing on the base of the metatarsal from the fissure (Figure 35) also supports the view that a burial was disturbed and broken up through the action of scavenging animals. The presence of extremities in the fissure makes a comparison with profile 6, residual remains of a secondary burial possible, but the presence of animal gnaw marks adds weight to the scavenging interpretation.

The comparisons drawn between the profiles of the later shell midden and fissure are more difficult to securely identify with one particular potential profile. However, it does not seem likely that these contexts contained disturbed or poorly preserved inhumation burials comparable with the cist.

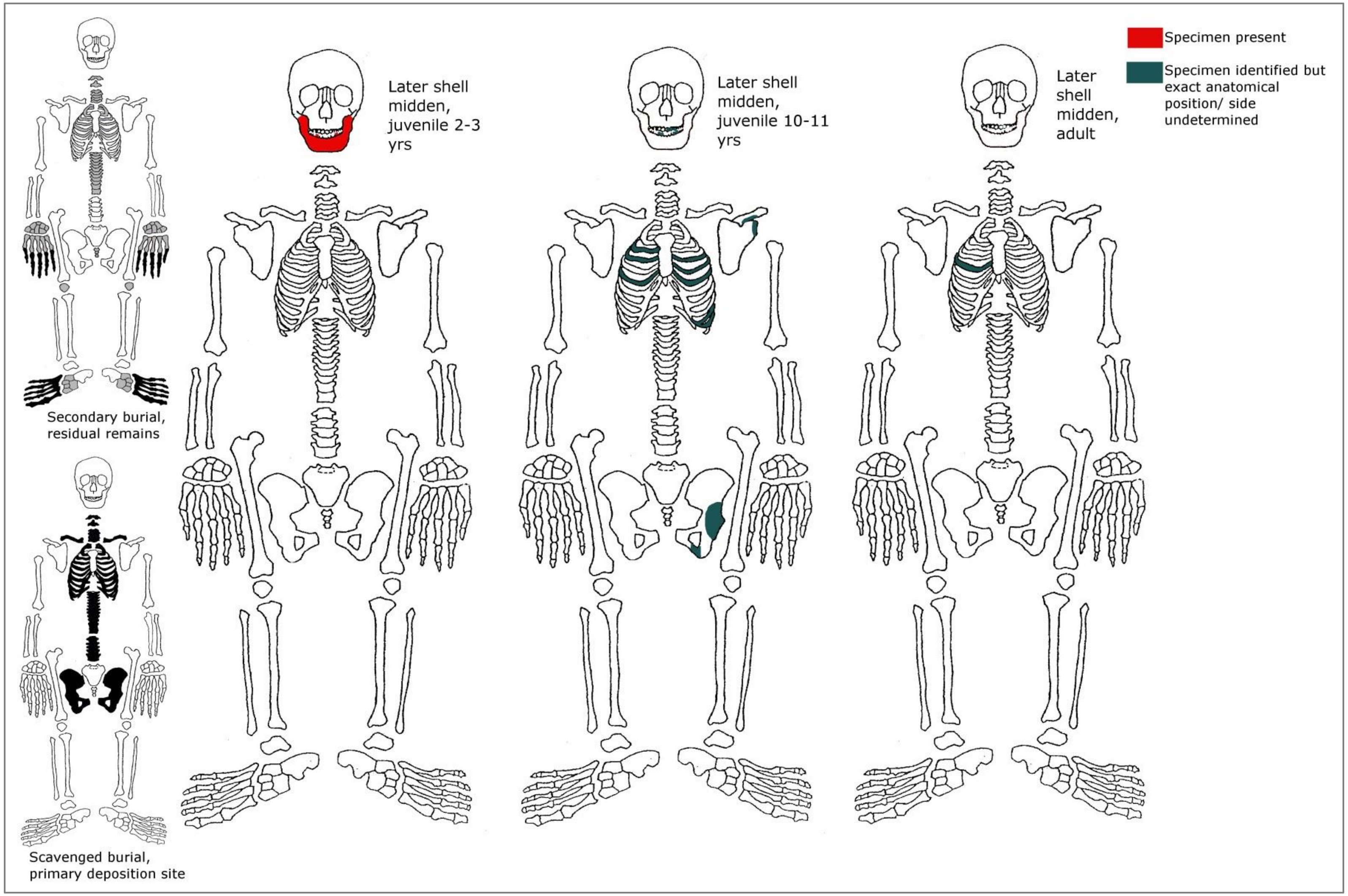


Figure 41: Comparison between the skeletal element profiles from the later shell midden and the potential profiles of a secondary burial and scavenged burial

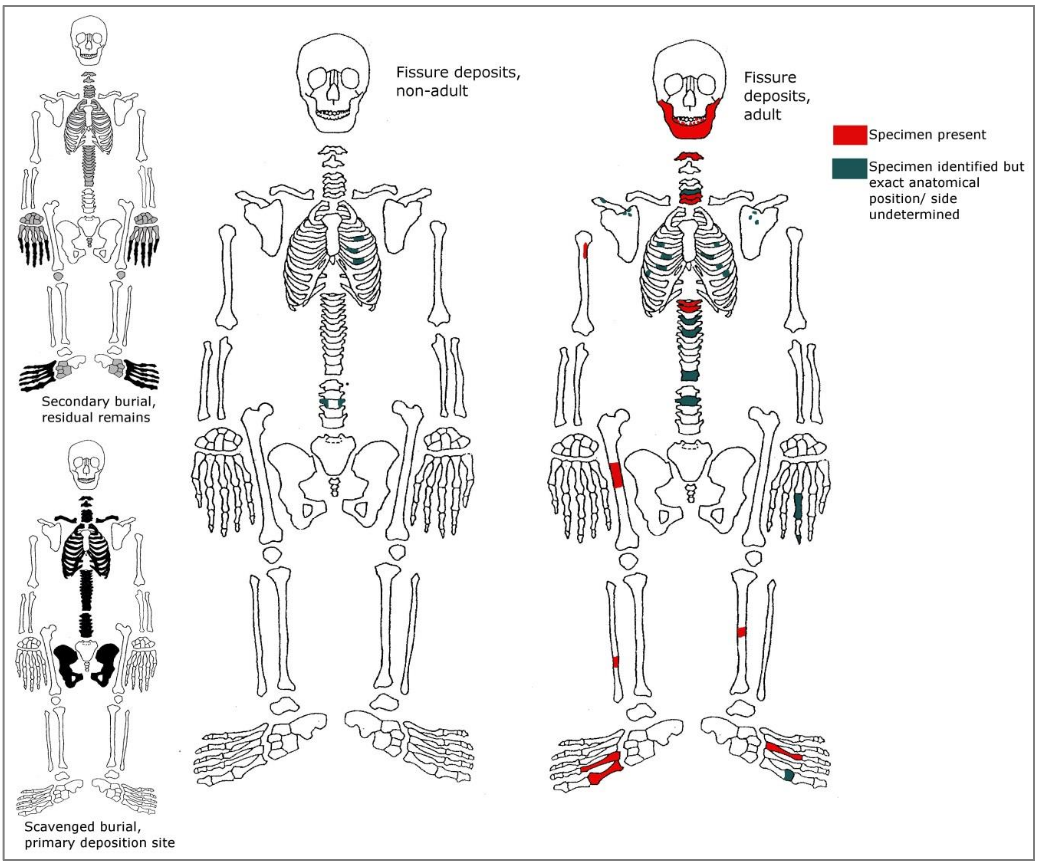


Figure 42: Comparison of the skeletal element profile from the fissure at Carding Mill Bay with the potential profiles of a secondary burial and a scavenged body

4.6 Burial practices at Carding Mill Bay

In summary the funerary and non-human taphonomic processes affecting the human remains at Carding Mill Bay are varied and illustrative of the complexity of treatment provided to human remains. The chi-squared analysis combined with consideration of the skeletal element profiles has shown that the earlier shell midden and unspecified midden differ statistically from the disturbed cist burial but are not, however, representative of comparable funerary practices. Whilst the fissure and later shell midden do not differ significantly from the cist burial, their skeletal profiles point to little similarities with a disturbed burial.

Given the semi-articulated nature of the vertebrae in the unspecified midden it is assumed that a whole body was placed at the site, probably covered or shallow buried in some way as there is no sign of weathering on the bones. Decomposition occurred causing either complete or partial skeletonisation of the bones at which point the larger elements of the skeleton were probably removed from the unspecified midden. These are likely to have been taken away from the site and subjected to secondary funerary rites. The bones which remained in the unspecified midden were then subject to further decay and taphonomic action at the site.

As there is a difference between the skeletal element frequencies of the cist and the earlier shell midden, which is unlikely to have been caused by non-human taphonomic factors, it is most likely that the funerary rite is the cause of the different bone profiles. The fact that there is a relatively high proportion of extremities found in the earlier shell midden context is made all the more remarkable by the lack of preservation of these elements in other contexts at the site and points to the fact that something entirely different from primary inhumation burial formed this context.

The likely taphonomic history of the bones from the earlier shell midden is that there were at least two stages of funerary treatment. The exact nature of the primary and secondary rites employed on the earlier shell midden remains is not clear but the treatment resulted in the inclusion of extremities, one vertebra and a small piece of skull, into the midden. The type of secondary rites attributed to the remains in the earlier shell midden are consistent with the residual assemblage of bones after certain portions of the body have been selected and removed from the site, unlike the unspecified midden which showed a whole body having a select few bones (mainly long bones) removed.

It has been previously suggested that the disarticulated bones present within shell middens might be the result of excarnation practices (Meiklejohn et al. 2005, 16), and ethnographic studies demonstrate that it is not always important to collect every last bone before a secondary practice is performed. The specimens in the earlier shell midden at Carding Mill Bay provides little evidence of cracking associated with weathering nor any animal gnawing present on the bones. This indicates that the earlier shell midden bones may have been placed at the site for primary funerary treatment and then left to sub-aerial defleshing but this was not a prolonged process. The bones were incorporated into the midden shortly after skeletonisation occurred and before any distinct weathering could take place. It is also possible that the body was covered in some way, by a thin layer of shells or perhaps animal hides, in order to protect the body from the effects of weathering and attack by animals and birds while the soft tissue decayed.

The other possibility is that the human remains in the earlier shell midden were not taken to the site as a whole body but that the bones were in a disarticulated state prior to inclusion in the midden. The small number of bones recovered and the lack of long bones suggests that the larger, more identifiable parts were subject to secondary funerary treatment elsewhere with the smaller bones from the extremities being incorporated into the shell midden.

Such a practice was considered for the placement of hands and feet at Cnoc Coig (Meiklejohn et al. 2005 16-17) where it was concluded that a “single purposive event” led to the deposition of the hands and feet groups at the site. At Carding Mill Bay it is not possible to ascertain whether there is any clustering of the bones due to a lack of specific spatial locations of the remains.

However, it is likely that had a noticeable cluster of human bones been found within the earlier shell midden context that this would have been recorded during excavation. Perhaps, rather than a whole hand or foot being placed in the shell midden as a purposeful act, which is postulated at Cnoc Coig (Meiklejohn et al. 2005, 16-17), small individual skeletal elements were placed into the shell midden as an act in itself.

Neolithic burial practices are widely known to involve disarticulating the skeleton before collecting and sorting the bones as an act of ancestral worship (Parker-Pearson 1999; Parker-Pearson 2000; Parker-Pearson 2005; Whitley 2002). In Neolithic tombs such as West Kennet, Wayland's Smithy and Fussell's Lodge it is believed that complex mortuary rituals took place involving some primary inhumation as well as some disarticulation and secondary processing of the corpse (Parker-Pearson 1999, 52; Whittle et al. 2007b, 105-108; Wysocki et al. 2007-69). In bone groups A1 and A2 at Fussell's Lodge there is an under-representation of hand and foot bones, compared to both other bone groups at the site and other broadly contemporary barrows (Wysocki et al. 2007, 67-69).

This is obviously a completely separate event from the Neolithic burial in the Carding Mill Bay shell midden but it serves to identify the possibility that Neolithic burial practices were complex and involved selection of certain body parts. Perhaps the Neolithic people placing the remnants of their dead into the late Mesolithic shell midden did so with the knowledge that the site was a place used by their ancestors, and therefore represents a type of continuity between the Mesolithic and Neolithic communities who used the site.

The later shell midden human remains do not differ significantly from the cist burial and are very incomplete, but nevertheless do show a different pattern to the earlier shell midden, with fewer extremities and more torso elements. With such fragmentary remains it is difficult to postulate a taphonomic history but it is likely that the remains are more indicative of primary funerary activity occurring at the site, evidenced by the presence of mandible and torso skeletal elements, which disassociate both early and late in the disarticulation process. The absence of many other bones perhaps suggests that most were collected from the midden to form part of a secondary funerary ritual elsewhere, and the bones that remain in the midden were simply left behind. There is also the possibility that the remains in the later shell midden were subject to scavenging, as the bone profile is comparable with the potential profile of a primary deposition scavenging site.

The articulated vertebral fragments and the lack of a statistically significant difference between the fissure burial and the cist implies that an intact body was placed into the fissure. It is accepted that some carnivore activity caused disturbance to the remains, including a gnaw mark present on one bone (Figure 35) and introduced animal bone into the deposit (Connock et al. 1992, 28).

Additionally, the presence of the mandible but absence of the cranium in the fissure deposit along with articulated vertebral fragments is indicative of carnivore activity on a body. If the head was scavenged after some decomposition and disarticulation had occurred then the mandible could have already been detached at the time that the skull was removed by animals.

The most likely taphonomic history for the human remains in the fissure deposit is that a primary inhumation burial was conducted after which some initial decomposition took place and then the cadaver was scavenged by carnivores, who removed the skull and most of the limbs. The semi-articulated vertebral column and some smaller bones which had already disarticulated were then left behind in the fissure deposit.

4.7 Conclusion

Around 3,700-3,400cal BC the first phase of human burial took place at the site. Small human bones, mostly from the hands and feet, were taken to the site and placed in/on a shell midden which might have been known to be formed by distant ancestors. The midden has been dated to the very end of the Mesolithic around 4,000 cal BC and included some distinctly Mesolithic artefacts, namely chipped stone, worked bone and antler (Connock et al. 1992, 31).

Sometime after this initial phase of burial, a second burial event took place involving the later shell midden, but the exact date of this phase is unknown. During this phase of burial at least three individuals were placed on the midden, probably as complete bodies, but it is not known whether these all occurred at one time or as a series of short, but distinct, events. After some decay of the bodies had occurred the majority of bones were collected from the site and presumably taken elsewhere for secondary funerary rites.

A third phase of burial activity took place around 3,000 cal BC, when an adult and non-adult were placed at the site, in the fissure in the cliff face. These bodies were left to decay, before being disturbed by carnivores who likely removed the flesh rich skull and limbs, leaving behind vertebral fragments and some scattered bones which had already disarticulated from the skeleton.

The final phase of burial practice occurred in the Bronze Age when a cist burial structure was placed at the site. This contained at least two individuals, an adult and a juvenile, whose bodies were placed in the cist intact. The cist was later disturbed by an unknown action causing the cist stone to become fractured and some of the bones to be lost.

Chapter Five: Cnoc Coig, Oronsay

5.1 Introduction

Oronsay is a small island in the Inner Hebrides on the west coast of Scotland (Figure 43). It lies directly to the south of the larger island of Colonsay. On the island, five shell middens are known: Caisteal Nan Gillean Sites I and II, Priory Midden, Cnoc Coig and Cnoc Sligeach.

The shell mounds on Oronsay were first recognised as sites of archaeological interest by William Galloway and Symington Grieve during work on the island in the early 1880's (Mellars 1987, 117). Caisteal nan Gillean I initially drew attention to the middens as it was a prominent cone shaped mound standing in the landscape (Figure 44) and it was the subject of excavation led by Grieve in 1881 and continued by Galloway in 1882 and 1883 (Mellars 1987, 118-20). Galloway also conducted excavations on two further shell middens, Cnoc Sligeach and Croc Riach, which has not been securely re-identified by modern studies. Further study of the Oronsay middens did not resume until A. Henderson Bishop and Mungo Buchanan carried out a series of excavations between 1910-13 (Mellars 1987, 126). They focussed their attention on two mounds in particular; Cnoc Sligeach and the "Viking mound" which has since been identified as Cnoc Coig (Mellars 1987, 127). The most intensive excavation took place on Cnoc Sligeach and discovery of stratified shell midden material and in situ raised-beach deposits led Bishop to conclude that the shell middens belonged to a "pre-Neolithic" period (Mellars 1987, 129).

No further fieldwork was carried out on the Oronsay middens until they were the subject of research excavations by Paul Mellars and his team between 1970-1979 (Mellars 1987). The aim of the excavations was to find out more about the economic, social and demographic organisation of the shell middens (Mellars 1987, 2). The project intended to conduct large-scale continuous area excavations of each midden in order to assess their age, seasonality, spatial organization, content and character. Mellars' research conducted excavations on all five of the identified middens; Cnoc Coig, Cnoc Sligeach, Caisteal nan Gillean I and II and Priory Midden. Due to logistical restraints such as finances and time, Cnoc Coig was chosen to be the main focus of the fieldwork with much smaller sampling trenches opened up for the other middens (Mellars 1987, 213). As only a sample was excavated for each midden it is possible that further human remains survive in these middens.

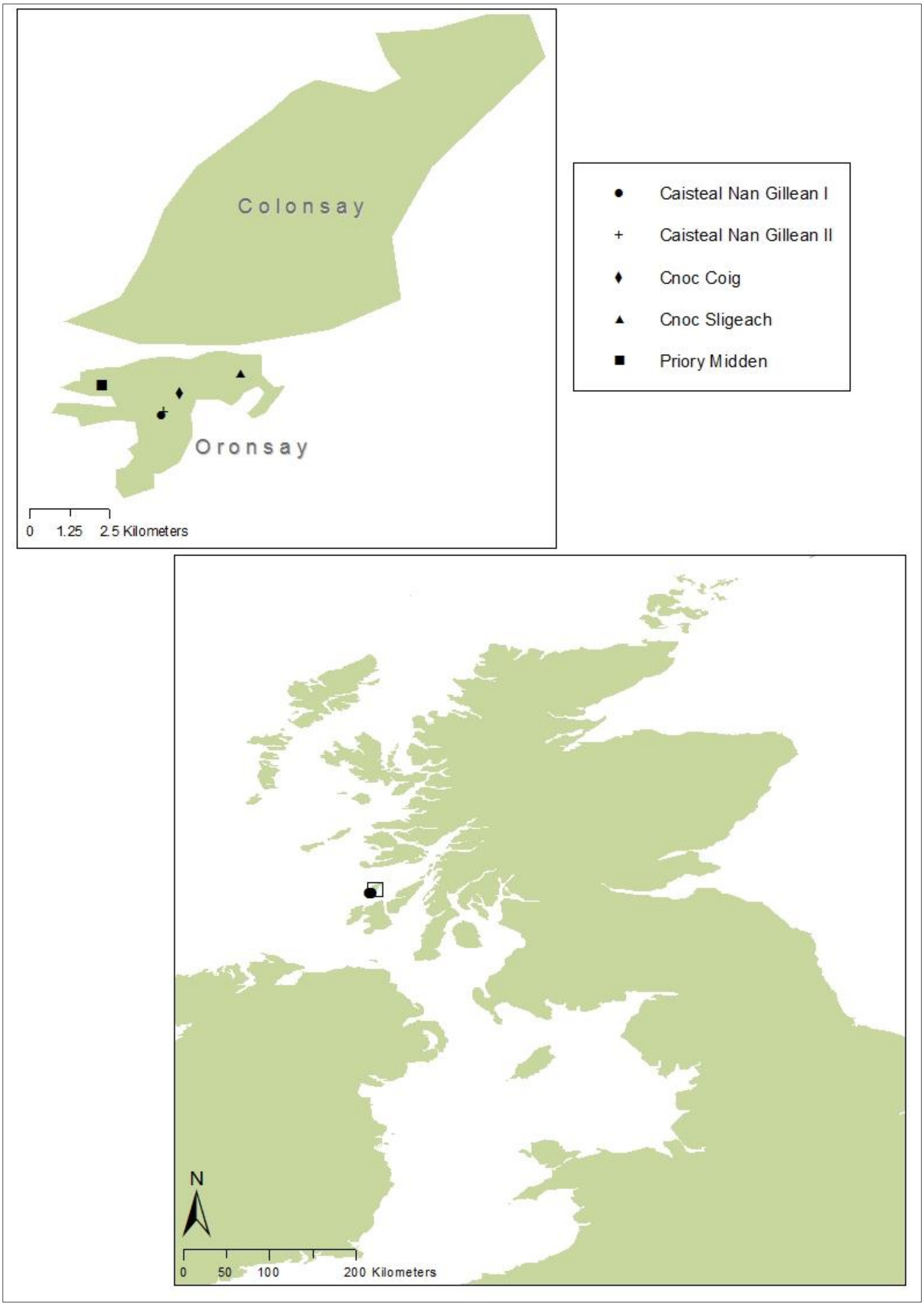


Figure 43: Location of Oronsay, Scotland and the five shell middens on the island

This chapter presents new analysis on bones, previously unstudied and found in the archive at the University of Cambridge. These human bones were located slightly outside the midden and therefore add new information to the understanding of human bone deposition at this site.

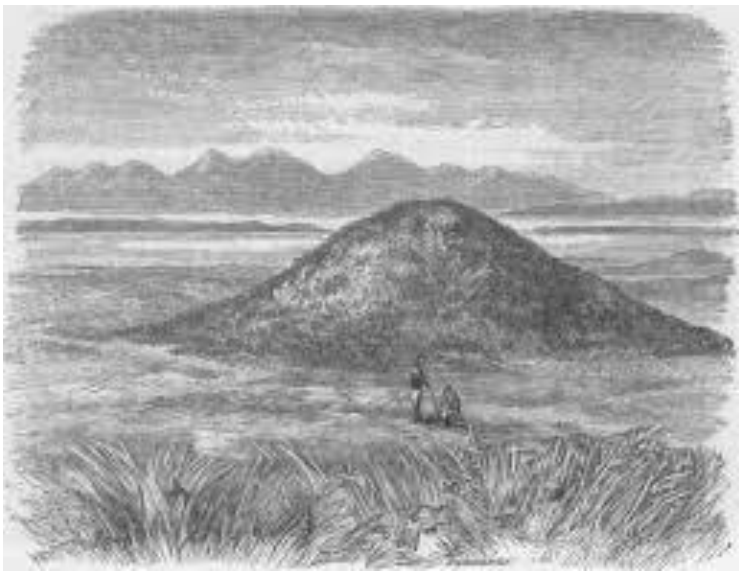


Figure 44: Engraving of Caisteal nan Gillean I shell midden on Oronsay, recorded at the start of investigations by Grieve and Galloway in 1881. (Mellars 1987, Figure 8.1)

5.2 Previous study of the human remains

5.2.1 Context of the human remains

Three of the five shell mounds studied by Mellars have been shown to contain human remains: Cnoc Coig, Priory Midden and Caisteal Nan Gillean Site II. A total of 55 human bone specimens were identified from these middens and published in detail by Meiklejohn and Denston (1987). The vast majority of the human specimens come from Cnoc Coig (49 specimens) which is likely to be a result of the intensity of excavation focussed on this site. The decision was made to omit the loose bones from Caisteal nan Gillean II and Priory Midden from a later analysis of spatial relationships at Cnoc Coig (Meiklejohn et al. 2005). This is presumably because the sample numbers are small; 5 and 1 specimens respectively, and their connection and contemporaneity with the Cnoc Coig remains has not been established. Therefore, the Cnoc Coig remains will form the focus for the remaining discussions.

The excavation methodology applied at Oronsay included the recording of full three-dimensional coordinates for all recognisable mammal bone (Mellars 1987, 135) making it possible to plot the exact location of each human bone specimen within the midden. A full analysis of the spatial relationships of the human remains at Cnoc Coig was carried out by Nolan as part of his PhD thesis (1986) and then published further by Meiklejohn et al. (2005). The bones were found to be distributed spatially in 5 groups with some additional "isolated bone" (Figure 45).

The seven bone specimens termed "isolated pieces" do not show any direct relationship to any other human bone on the site (Meiklejohn et al. 2005, 88-9). Groups 1 and 5 are pairs of bones which are located in areas of the midden where no other human remains are found (Meiklejohn et al. 2005, 89). Group 4 is a collection of 4 bones which are loosely grouped together, away from any other human remains in the south west area of the site. Therefore groups 1, 4 and 5 were seen as "minor bone groups" (Meiklejohn et al. 2005, 93) because of their similarity to the loose isolated bones, rather than being distinct groups.

The main bone groups forming the bulk of Meiklejohn et al.'s study (2005) are groups 2 and 3 (Figure 45). Nolan (1986) originally identified these as four groups of bones, the larger groups being 2a and 3a each of which had a small associated bone group; 2b and 3b respectively. Re-fitting analysis demonstrated that bones within these sub-groups were likely to be part of the same individual skeleton and the smaller groups 2b and 3b could therefore be considered part of their larger counterparts 2a and 3a (Meiklejohn et al. 2005, 93).

5.2.2 Skeletal elements present

88% of group 2 and 72% of group 3 are hand and foot bones (Meiklejohn et al. 2005, 93) and such high proportions of hand and foot bones, as well as the fact that they are grouped together is thought to be representative of a distinct depositional event, particularly group 3a which is the most compact group (Meiklejohn et al. 2005, 91). Such focus on extremities is thought to be unique to the Oronsay middens (2005, 102). Additionally, there is a close stratigraphical relationship between the hand and foot bones in group 2 and seal flipper bones (Meiklejohn et al. 2005, 101) further suggesting that the human extremities and seal flipper bones were deposited as part of a purposive event (Meiklejohn et al. 2005, 102-3).

In contrast to the purposive cultural act proposed for the bones in groups 2 and 3 the skeletal elements which were found in the minor groups, and as isolated remains, are similar to a pattern of deposition identified by Meiklejohn et al. in Scandinavia, Germany and the rest of Britain where there is a general lack of trunk (ie. vertebral column), shoulder and pelvis bones and a presence of crania, teeth, upper and lower limbs (Meiklejohn and Denston 1987, 298). Meiklejohn et al. attribute the source of the loose human remains in the midden as a disturbed primary inhumation burial from elsewhere on the midden and not a "purposive cultural act" (Meiklejohn et al. 2005, 102).

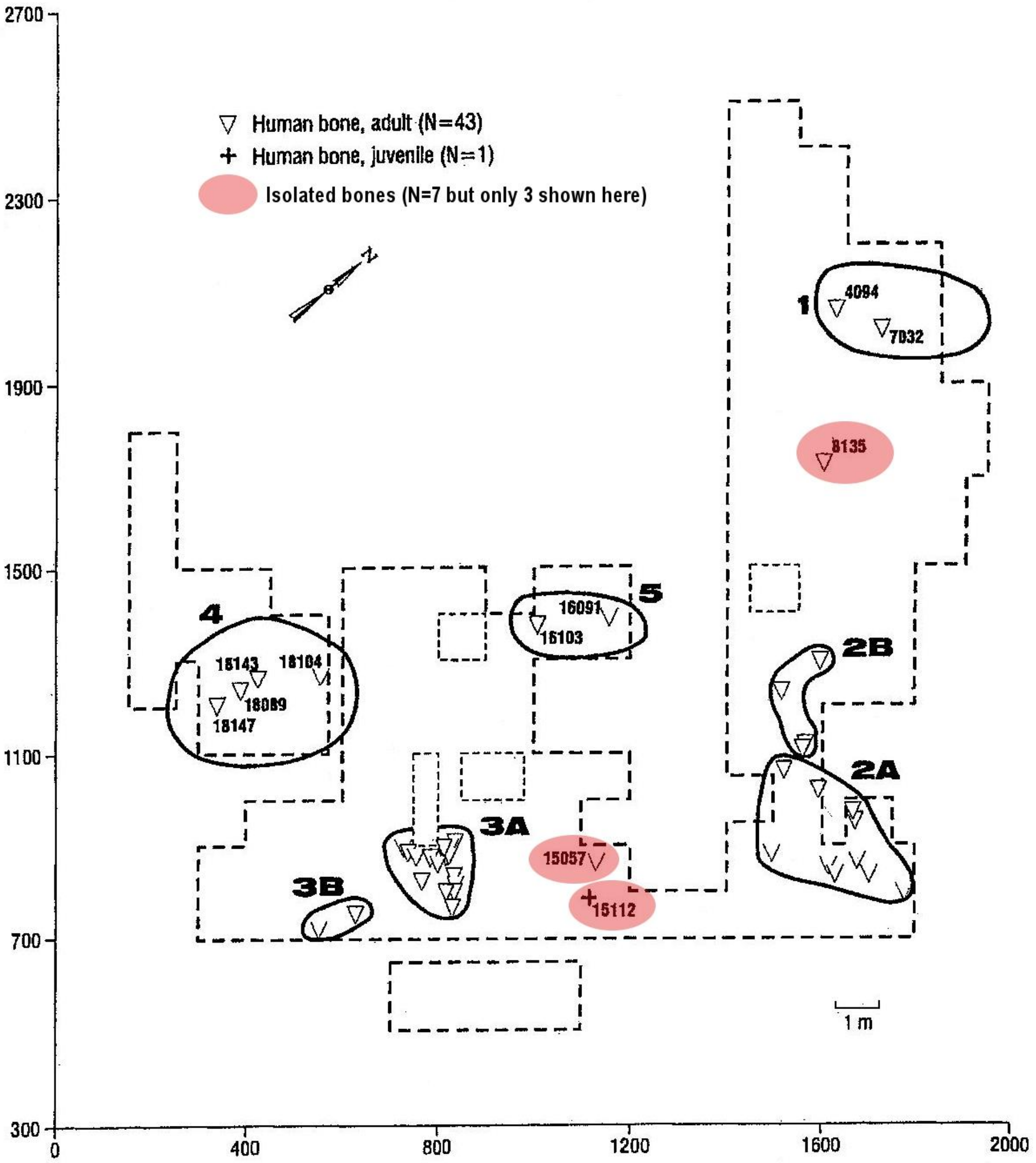


Figure 45: Spatial location of human bone specimens at Cnoc Coig, showing bone groupings identified (Meiklejohn et al. 2005)

The possibility of the human remains at Cnoc Coig being the result of excarnation practices on the body is considered by Meiklejohn et al. (2005, 100), as such practices have been demonstrated in Neolithic examples of disarticulated bone assemblages. However, comparisons with Neolithic assemblages at Hambledon Hill and Hazleton North suggested to Meiklejohn et al. that the Cnoc Coig pattern, with a predominance of extremities, was not comparable to an excarnation pattern of disposal (Meiklejohn et al. 2005, 100).

5.2.3 Age and sex

The majority of bone specimens found at Cnoc Coig were adult but one axis fragment (15112) was unfused and therefore represented a juvenile (Meiklejohn and Denston 1987, 296). Further refinement of the ageing was difficult due to the fragmentary nature of the bones but Meiklejohn and Denston (1987, 296) report that there was limited evidence of degenerative joint disease implying that there were few remains belonging to individuals over 50.

The assemblage from Cnoc Coig does not contain many specimens from the cranium or pelvis, which are key skeletal areas in the sexing of remains. However Meiklejohn and Denston suggest that one pelvis specimen is likely to be female (16091) and that the four clavicles are sufficiently varied to suggest that both sexes might be represented (Meiklejohn and Denston 1987, 297), however, secure sexing of the remains is not possible.

5.2.4 Minimum number of individuals

A refitting experiment identified fits between bones indicative of relationships between groups as well as helping to refine the MNI at the site (Meiklejohn et al. 2005, 92-7). This analysis showed that in the minor bone groups and isolated bones there were no anatomical fits between bones but there was duplication of two left clavicles, suggesting that the bone derived from an MNI of two (Meiklejohn et al. 2005, 93). In group 2 there is a pair of left medial and distal 5th digit hand phalanges and a pair of right medial and distal 5th digit hand phalanges. Meiklejohn et al. state that these pairs are not left and right sides from a single individual meaning that they belong to a MNI of two (Meiklejohn et al. 2005, 92-3). Additionally, there is a second left medial 5th digit phalanx which also does not pair with the right one, indicating that there must be a MNI of three individuals represented in group 2 (Meiklejohn et al. 2005, 92-3).

Similarly, group 3 contains a MNI of three shown by the presence of two right medial 2nd digit hand phalanges, neither of which seems to be a side/side antimer with the left medial 2nd digit hand phalanx from the same group (Meiklejohn et al. 2005, 92-3).

The question whether the individuals identified *within* the groups were the same people *across* the two groups was addressed by Meiklejohn et al. and their conclusion was that there were strong arguments, in the form of vertical stratigraphy and only low certainty refitting of bones, against inter-group linkage (Meiklejohn et al. 2005, 93). This lead them to the conclusion that the MNI at the site is eight; three in group 2, three in group 3 and two in the minor groups and isolated bone.

5.2.5 Taphonomic indicators

No indications of taphonomic alterations to the bone were recorded except one which shows evidence of burning (4094) but it is thought that this is inconsequential given its unique nature amongst the human bone assemblage (Meiklejohn and Denston 1987, 290).

5.2.6 Dates

Cnoc Coig was dated in the 1970s using bulk charcoal samples and shell; however, all of these dates have large standard deviations on them and associated problems such as the marine reservoir effect on shell and old wood effect for wood. More recently, four human bones were dated (Richards and Mellars 1998; Richards and Sheridan 2000); however they demonstrated a high marine diet and so needed to be corrected for the marine reservoir effect (Table 15). Although this was done for the original dates (Figure 46), further research into the marine reservoir effect by Ascough et al. (2007) showed that these dates should be recalibrated again, and were done so by Gordon Cook (Milner and Craig 2009). The results suggested that the human bones are more likely to date to the beginning of the 4th millennium cal BC (Figure 47).

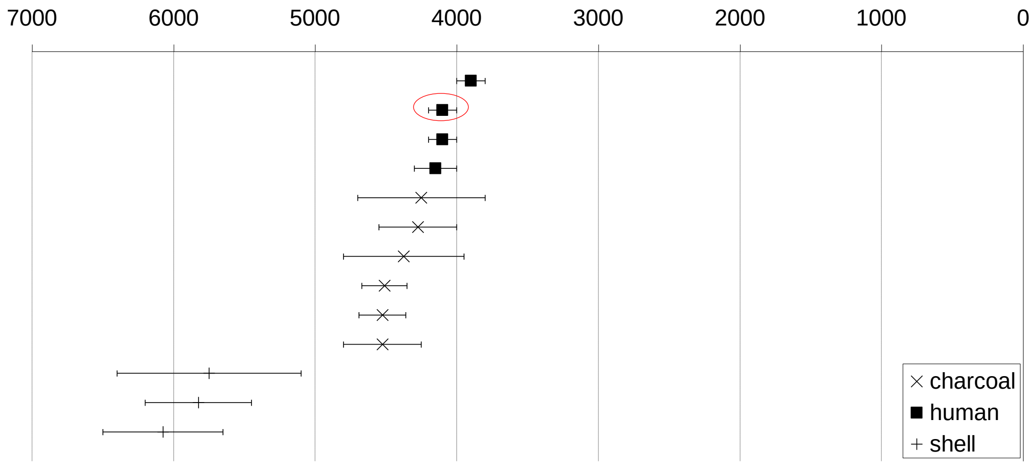


Figure 46: Radiocarbon dates obtained at Cnoc Coig and Caisteal nan Gillean II (ringed in red) (Milner and Craig 2009, Figure 15.7)

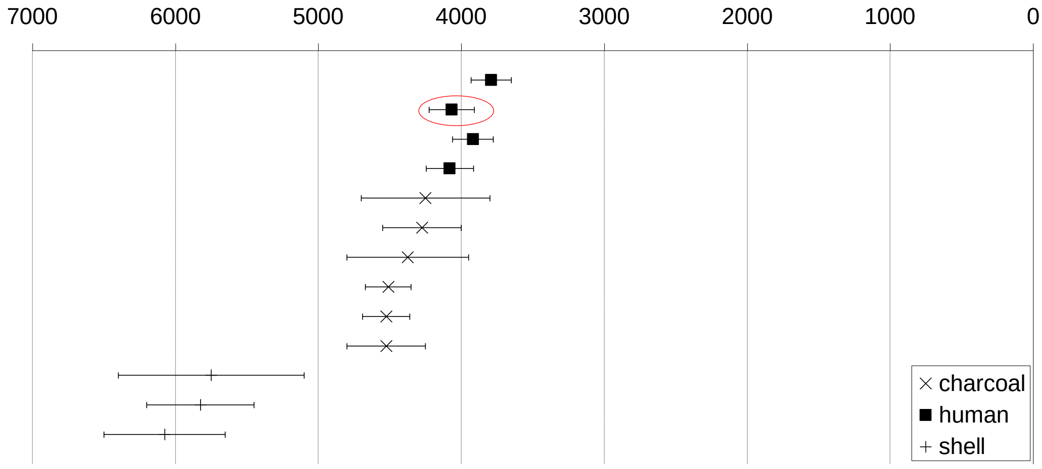


Figure 47: Re-calibrated radiocarbon dates at Cnoc Coig and Caisteal nan Gillean II (ringed in red) (Milner and Craig 2009, Figure 15.8)

The dates on human bone from the site span 4,000cal BC (Figure 47 and Table 15) which is commonly agreed as the approximate date when the transition from the Mesolithic to the Neolithic occurred in Britain suggesting that the placement of human remains into this midden occurred at a time when a significant economic change was taking place. The radiocarbon dates are not sufficiently distinct to suggest that they are from different depositional episodes, and are not taken from bones which can be securely identified as different individuals, meaning that it is only possible to say that groups 2 and 3 were incorporated into the midden at the same time, or very close together in time. The human remains in groups 2 and 3 are likely to form part of the same, or very similar, funerary processes given their distinct skeletal element profiles and their closeness in date.

5.3 New analysis on human remains from Oronsay

A set of previously unstudied bones were examined at the McDonald Institute for Archaeological Research, University of Cambridge in July 2011, these were labelled as “Cnoc Coig, Area UIII, Sept 11 1975”. Trench UIII was an additional trench outside of the main midden (Figure 48). The bones were in an unprocessed state, having been bagged and stored unwashed since their excavation in 1975 (Figure 49). Through examination a number of the observed specimens were identified as probable human specimens. These specimens were not known to the authors of the original publications (Meiklejohn 2011, pers comm.), perhaps because they were found outside of the midden, and so had not been included in the interpretation of the site which focused more on the midden itself.

Lab Code	Bone Number	Context	Material	δ C13	Radiocarbon age BP	Re-calibrated dates, 2 sigma cal BC	Source
OxA-8014	17203	Group 3	human, left 3rd metacarpal	-12.0	5495 +/- 55	3930-3650	(Milner and Craig 2009, Table 15.6; Richards and Sheridan 2000, Table 1)
OxA-8005	1281	Caisteal nan Gillean II trench P/N	human, left 3rd metatarsal	-16.0	5480 +/- 55	4230-3910	(Milner and Craig 2009, Table 15.6; Richards and Sheridan 2000, Table 1)
OxA-8019	17157	Group 3	human, left clavicle	-12.4	5615 +/- 45	4060-3770	(Milner and Craig 2009, Table 15.6; Richards and Sheridan 2000, Table 1)
OxA-8004	18284	Group 2	human, right 1st metacarpal	-12.4	5740 +/- 65	4250-3910	(Milner and Craig 2009, Table 15.6; Richards and Sheridan 2000, Table 1)

Table 15: Radiocarbon dates taken on human bone from Cnoc Coig and Caisteal nan Gillean II. Radiocarbon dates were obtained by Richards and Sheridan (2000) Calibrations are based on marine diet and revised delta-r values from Milner and Craig (2009).

The box in which the newly identified human remains were found mainly contained unidentified animal bone which was in a fragmentary state. The newly identified human remains were also fragmentary in nature and were individually bagged and labelled with context numbers along with a note of "Sept 11, 1975 UIII".

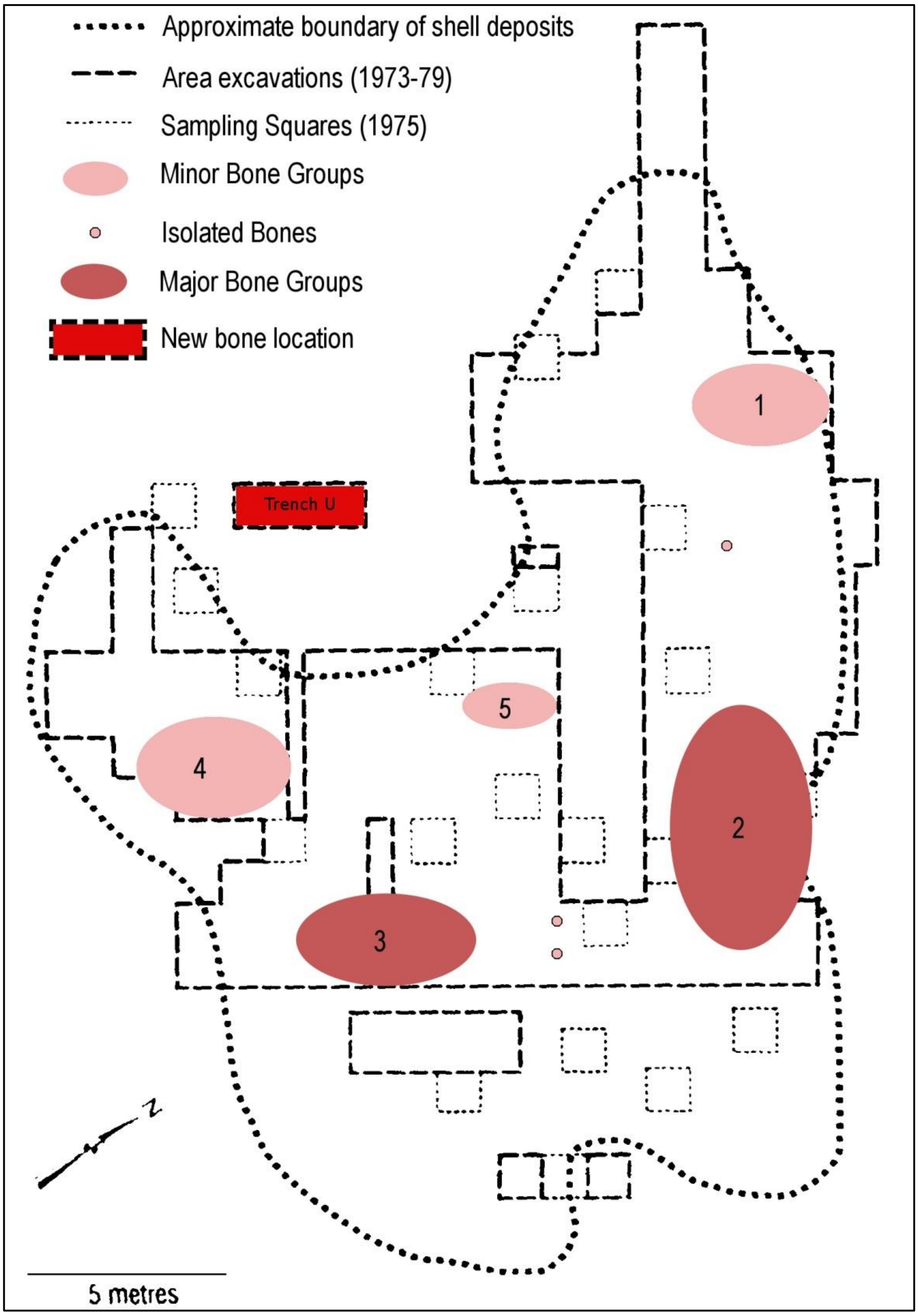


Figure 48: Location of human bones at Cnoc Coig, showing bone groups, location of new bone specimens and extent of the midden deposits. (After Meiklejohn et al. 2005, 90 Figure 3). Note the number of isolated bones found was seven but only three were plotted by Meiklejohn et al. as three of the remaining bones were found through sieving and the fourth was found stratigraphically above group 3A.

Figure 49: Photograph of newly identified human vertebral fragments (Context Number 8260) from Cnoc Coig, trench U.

There is little mention of trench U in the site report (Mellars 1987), it is merely included on some of the plans of Cnoc Coig, indicating that it was excavated in the 1975 season and that it lies outside of the midden deposits. No discussion of the stratigraphy or content of the trench can be found, indicating that it was not regarded as an important aspect of the excavation by Mellars.

In total, 23 new pieces of bone were identified from trench U, with the majority of bones being rib fragments. One extremity was identified, a probable metacarpal (Figure 50) which was labelled as a "general find found in sieve, material from around bone cluster".

Figure 50: Probable metacarpal found as a "general find" in trench U at Cnoc Coig

It is not possible to assess the contemporaneity of the isolated bones from the midden with the bones in trench U. It is understood that two new dates have been obtained on human remains from trench U (Charlton 2015, pers comm.) and these dates might provide some clarification on whether they are contemporary to the deposition of groups 2 and 3 but these dates have not yet been published.

For the purposes of further discussion of the bone groups they will be referred to as *major bone groups* and *minor bone groups.* Groups 2 and 3 identified by Meiklejohn et al. (2005) will be referred to as the *major bone groups* and Meiklejohn et al.'s groups 1, 4 and 5, their "isolated bones" and the newly identified bones from trench U will be referred to as the *minor bone groups,* (see Figure 51).

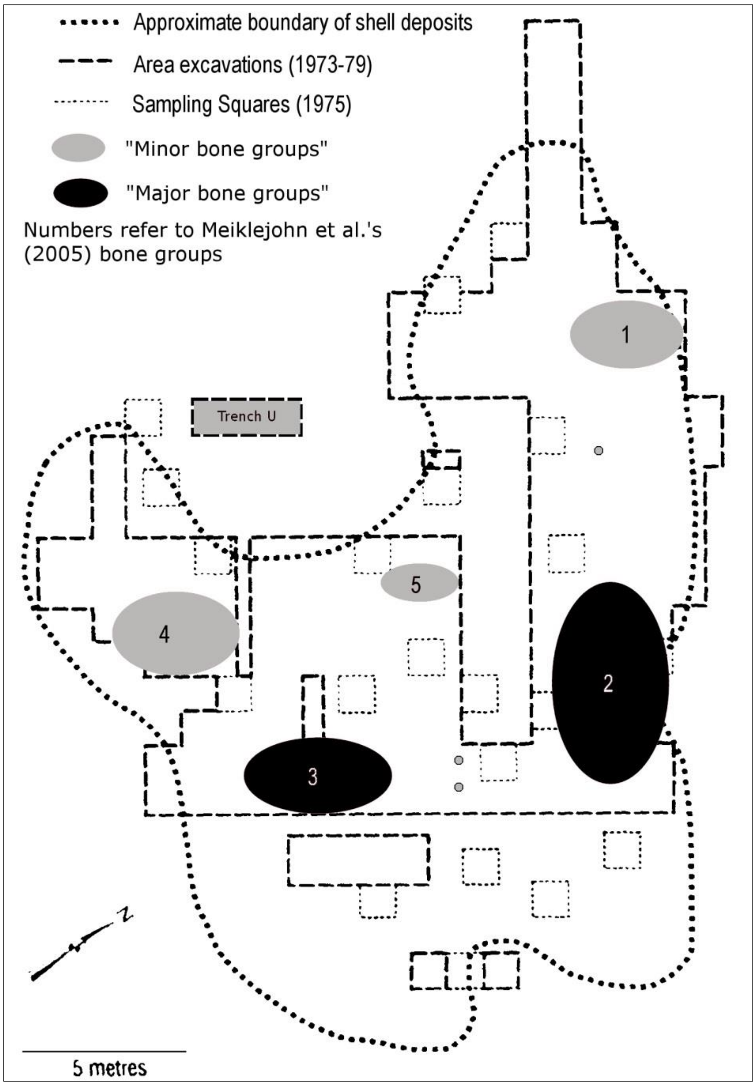


Figure 51: Plan showing the nomenclature for the bone groups at Cnoc Coig applied in this study, (after Meiklejohn et al. 2005)

5.3.1 Age and Sex

No secure ageing or sexing could be conducted on the newly identified human remains due to their fragmentary nature and lack of diagnostic elements.

5.3.2 Minimum number of individuals

Previous work on the human bones identified a MNI of eight in the Cnoc Coig midden (Meiklejohn et al. 2005, 93). It is important to note that although Meiklejohn et al.'s re-fitting analysis did not find any fits involving the bones from either the minor groups or the isolated bones (Meiklejohn et al. 2005, 92-7), this might be a result of the bones present rather than lack of fit. Few of the bones present in groups 2 and 3 are of a comparable area of the skeleton to those in the minor groups and the isolated bone, therefore the lack of fit is uncertain and the bones could be attributable to the same individuals, giving a revised MNI for this study of five; three in groups 2 and 3 and two in the minor groups.

The newly identified bone in trench U did not provide any conclusive ageing, therefore prohibiting a refinement of MNI on this basis. Additionally, it is not possible to refine the MNI at the site by consideration of repeated skeletal elements as there are no repeats seen amongst the trench U assemblage or between trench U and the other groups at the site.

5.3.3 Taphonomic indicators

The human bones from trench U could not be thoroughly assessed for taphonomic indicators due to the uncleaned nature of the specimens.

5.3.4 Skeletal elements present

A full inventory of all of the human bones found in all three Oronsay middens is provided in Appendix 5 based on data presented in Meiklejohn and Denston (1987), Meiklejohn et al. (2005) and the newly identified human remains presented in this study. The predominance of extremities present in the major bone groups, 2 and 3, is not repeated in the minor bone groups or trench U (Table 16 and Figure 52). The minor bone groups contain more bones from the trunk and limbs and fewer extremities.

NISP (excluding teeth)	Skull	Vertebral Column	Rib cage	Upper limbs	Lower limbs	Extremities
Group 2	0	2	0	0	0	14
Group 3	1	1	0	2	1	13
Minor groups	3	6	6	2	2	4
Trench U	3	6	11	1	1	1

Table 16: Summary of skeletal specimens at Cnoc Coig, including those identified by Meiklejohn et al. (2005) and the newly identified specimens from trench U

Chi-square analysis for goodness of fit shows that the bones in trench U are not significantly different from those found in the minor bone groups and the isolated bone at Cnoc Coig (χ^2_c (5)=2.56, p≥0.01) (see Appendix 6 for full workings). Their proximity to each other on the same site and the similar profiles of skeletal elements (Figure 52) suggests that they are likely to have originated from a similar process. They all contain very fragmentary specimens from the skull and trunk with a small proportion of extremities. One noticeable difference in the profiles is that the assemblage from trench U contains a humerus specimen, the only long bone fragment to be found in the loose bone and minor groups at Cnoc Coig. Robust, cortical bone like that in the long bones is likely to survive well (Merbs 1997) but only one such human long bone has been found on the whole of the Cnoc Coig site. It is possible that its placement at Cnoc Coig is unusual and not representative of the main depositional processes present at the site.

When the major bone groups with large numbers of extremities are compared to the minor bone groups at Cnoc Coig using chi-square analysis it shows that the major bone groups do differ significantly from the other groups at the site (Group 2: χ^2_c (5)=36.81, p≤0.01, Group 3: χ^2_c (5)=25.98, p≤0.01) (see Appendix 6 for full workings). This indicates that it is statistically likely that the taphonomic histories of the major bone groups differed from the other minor bone groups at the site.

5.4 Burial processes at Cnoc Coig

It has been shown that the skeletal element profiles of the major bone groups at Cnoc Coig differ significantly from the minor bone groups and trench U, indicating that it is probable that a distinct taphonomic process led to their deposition in the midden. It has also been shown that trench U's bone profile does not differ significantly from the other minor bone groups and isolated bone at the site implying a similar taphonomic history. The distinct nature of the deposits is evident when considering the spatial location of the different skeletal elements (Figure 53). It is clear that there are distinct clusters of mainly extremities in the major bone groups on the midden. Most specimens from other parts of the skeleton are found away from the groups of extremities in other parts of the midden and even outside of it in trench U.

Meiklejohn et al. attributed the presence of loose human remains from the minor bone groups to be the result of a disturbed inhumation burial rather than a purposive cultural act (Meiklejohn et al. 2005, 102). However, this seems unlikely as the bones were distributed over an area of around 150m^2 (see Figure 53) which would be a very high level of disturbance unlike that seen in other middens where primary burials are moved to make room for new ones. For example, at Téviec and Hoëdic the original primary interments were simply pushed to one side to make room for the new burial (Schulting 1996, 339), rather than being distributed away from the original burial location.

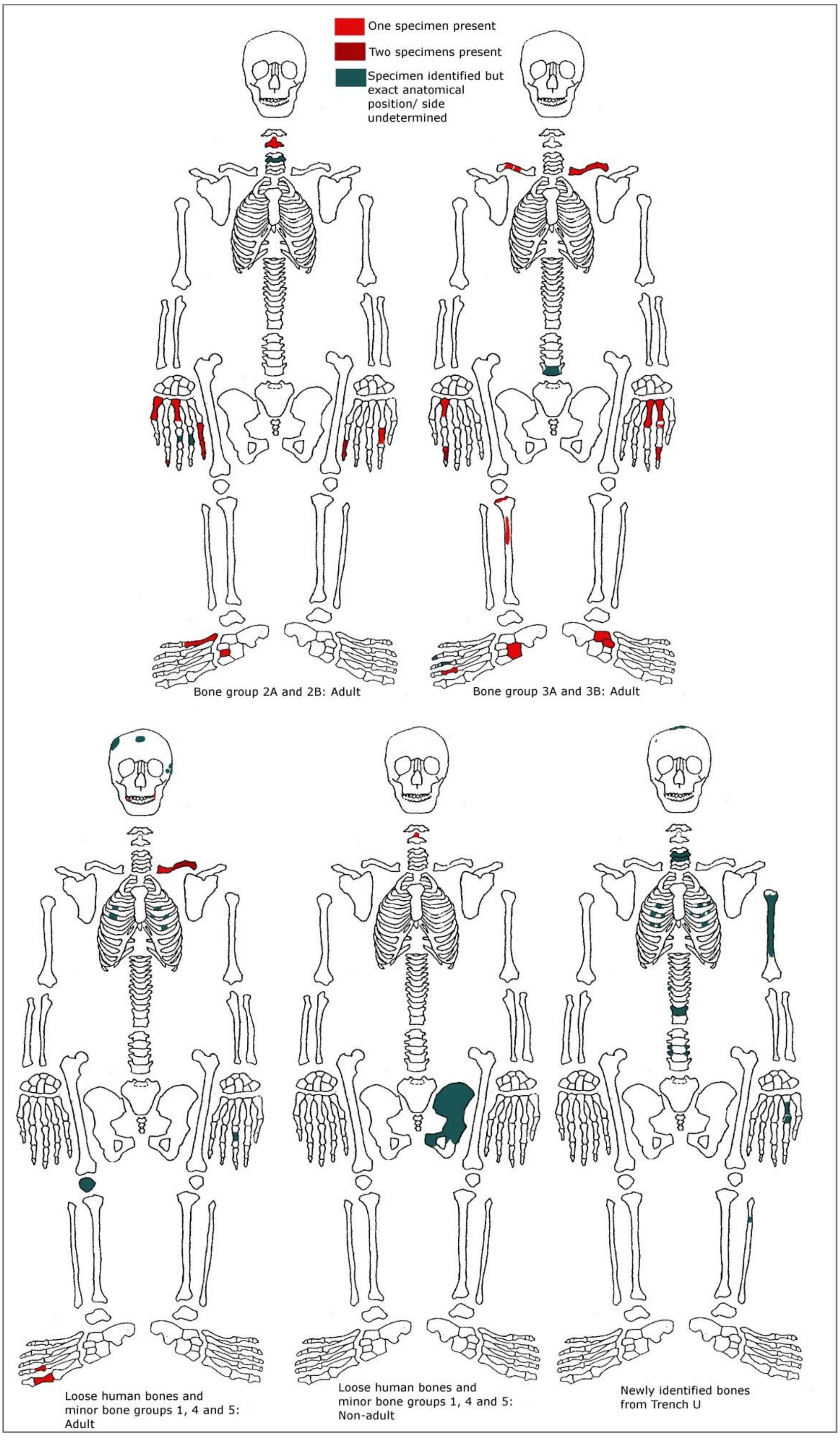


Figure 52: Skeletal element profile diagram of all human bone specimens at Cnoc Coig, Oronsay

The stratigraphic analysis of the Cnoc Coig midden indicates that there were three distinct phases of occupation each characterised by repeated and rapid depositions of shells (Mellars 1987, 228). Also discernible within the shell deposits at the site are a semi-circular arrangement of stake holes which, along with a central hearth, were deemed to be evidence of an occupation structure (Mellars 1987, 227). Such clearly defined and seemingly undisturbed stratigraphy on the midden does not fit with the possibility that a primary inhumation burial placed on or within the same midden was disturbed and redistributed over an area spanning 150m^2. Additionally, the good preservation state of the bones on the midden shows that conditions were conducive to bone survival and therefore if a complete burial had been placed at the site a more representative sample of the skeleton would be expected to be present.

The specimens from the minor bone groups and trench U are perhaps most similar to profile 3, the primary site of scavenging by carnivores, or profile 6, the primary site of bones subject to multiple burial practices (see Figure 54), but the specimens are very small in number and do not seem to fit closely with either pattern. However, when the distinct depositional pattern of the major bone groups is considered the seemingly random pattern of bones from the minor bone groups becomes clearer.

Owing to the close clustering of the hand and foot bones in the major groups (Figure 53) and the refitting of the specimens (Meiklejohn et al. 2005) showing that the bones are likely to have originated from three individuals, it seems that these bones are likely to have been intentionally deposited in the midden. The close association of group 2 with bones from a seal flipper (Meiklejohn et al. 2005, 101) also adds weight to the conclusion that selected bones from the extremities were purposively placed in the shell midden as a single event.

Chi-square analysis (Appendix 6) shows that the skeletal element profiles of Groups 2 and 3 are statistically different from those in the rest of the Cnoc Coig site, implying that a different taphonomic process led to their deposition. However, this does not necessarily mean that a different *funerary* process was taking place. The depositions of the extremities found in the major bone groups and the other specimens from the minor bone groups could be part of the same funerary process which involved breaking up the body for intentional funerary deposition both in the midden and elsewhere.

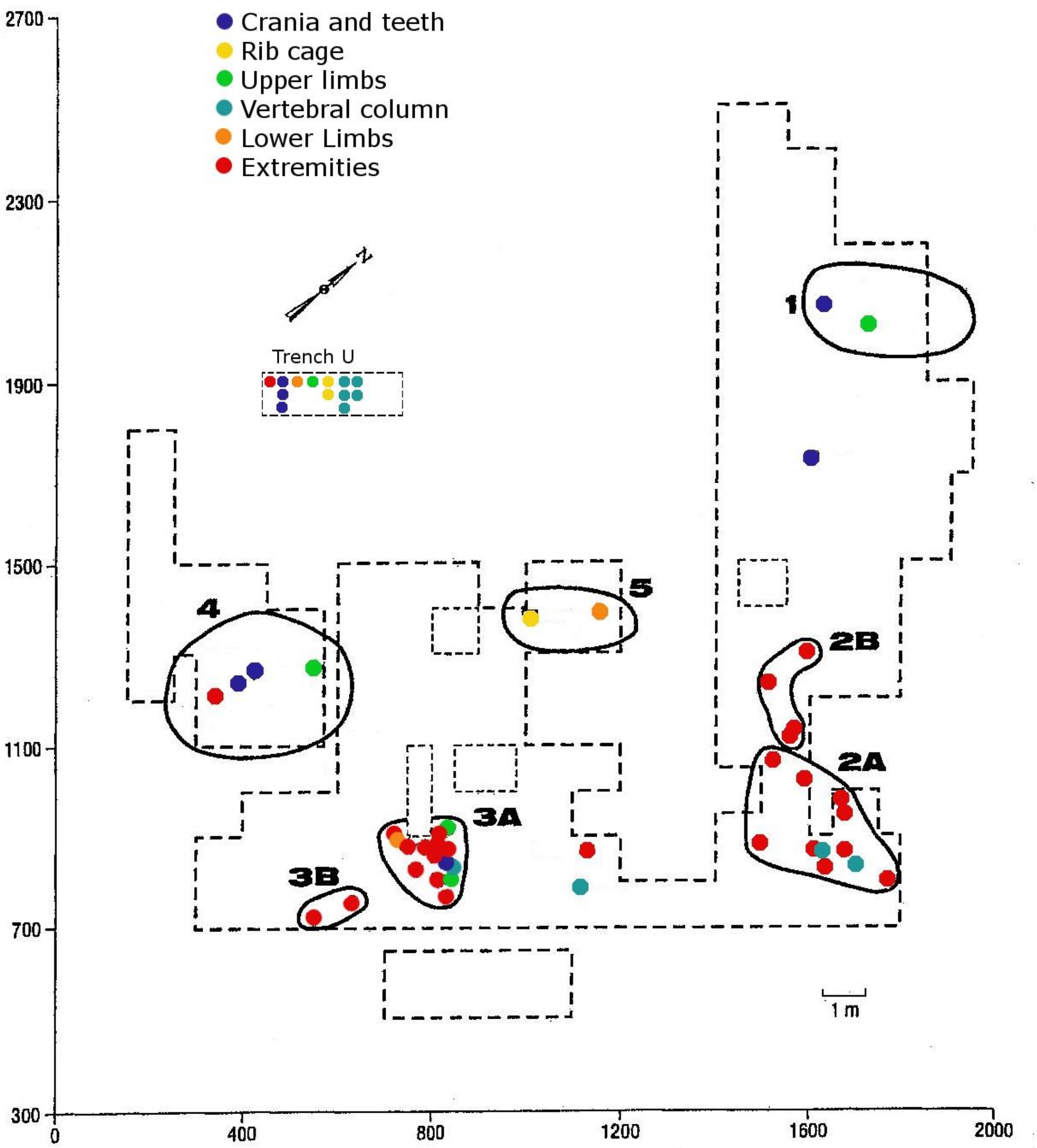


Figure 53: Distribution of skeletal elements at Cnoc Coig. Note the spatial locations of bone specimens in trench U are not known and the dots are therefore indicative of presence of skeletal element only, not position (after Meiklejohn et al. 2005)

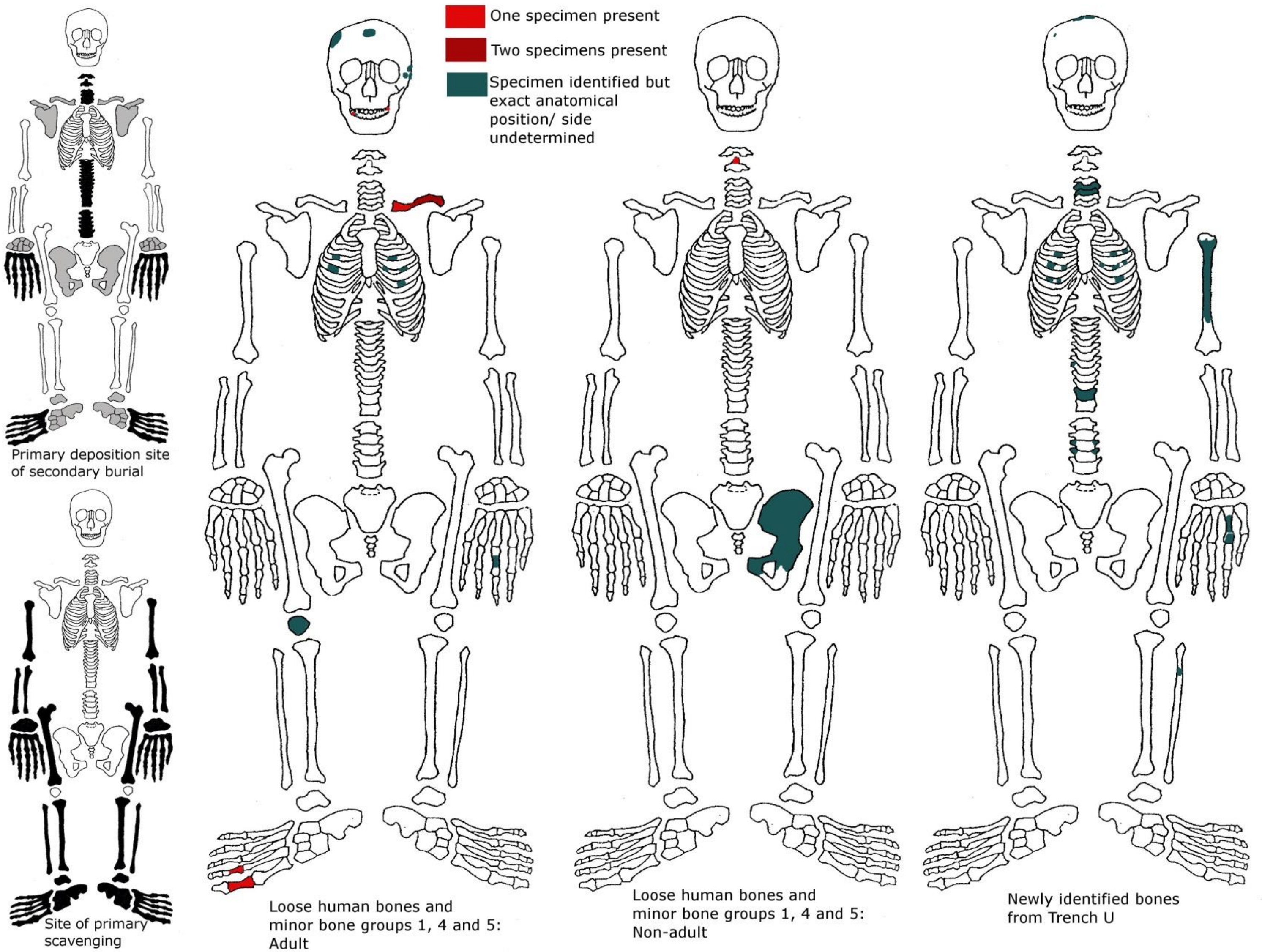


Figure 54: Skeletal profile diagram showing profiles of isolated bone, minor bone groups and trench U at Cnoc Coig with potential bone profiles of secondary burials and scavenged remains

The missing bones from the assemblage at Cnoc Coig are the exact bones which *would* be likely to survive in a poorly preserved or disturbed inhumation burial and the bones present at Cnoc Coig are often lost from inhumation burial excavations (Mays 1992). Additionally, the bones recovered at Cnoc Coig displayed an excellent preservation condition (Meiklejohn et al. 2005, 92). The favourable conditions for bone survival in the midden and the presence of bones which are often lost from burial remains are not indicative of a poorly preserved inhumation burial but instead imply a funerary process which caused the bones to be deposited in a disarticulated state.

Until further dating is carried out on the isolated remains, minor bone groups and trench U, firm conclusions cannot be drawn about their contemporaneity to each other or to the major bone groups but it is possible to see the two processes evidenced here as part of the same funerary treatment. If the groups are contemporary it is likely that three to five individual bodies were brought to the shell midden site, where they underwent a process to deflesh and break up the body. This may have been excarnation on a platform, although no sun bleaching or weathering has been recorded on the bones. Alternatively, the bodies may have been butchered to disarticulate the bones but no cut marks have been found. This is not unexpected as the parts of the body where cutmarks would be anticipated to be found are not present in the assemblage. Cutmarks associated with dismemberment would be expected in the joint areas, that is on long bones near the epiphyses (Graver et al. 2002, 318). A third possibility, given the lack of weathering and cutmarks is that the bodies were covered in some way, perhaps in a shallow grave or with shells from the midden, until sufficient decomposition had taken place to disarticulate the skeleton.

Although the trench U skeletal specimen profile is not significantly different from skeletal elements in the midden itself, it does seem as if there are fewer extremities and more trunk bones contained within trench U (Figure 53). If the bones in trench U could be shown to be contemporary and comparable to those found in the midden it is possible that trench U was the site where some processing of the body occurred prior to the deposition of selected elements, particularly hands and feet, into the midden.

Once the skeletons were in a disarticulated state the bones would have been collected ready for secondary treatment. Some bones may have been left behind whilst this collection was taking place and therefore became incorporated into the midden and beyond in the vicinity of trench U as loose, isolated bone and the minor bone groups. Additionally, an intentional secondary placement of hand and foot bones was made into the midden along with seal flipper bones and formed the major groups and before the remaining parts of the body were taken away from the site for their own secondary funerary treatment. Perhaps similar to the placement of hand and foot bones in the shell midden, the other parts of the body were placed in alternative significant places within the landscape or even other parts of the midden, but which have not yet been found by archaeologists.

The interpretation presented here should be reconsidered in the future if further dating of the human remains is carried out but it is clear that the Cnoc Coig shell midden was a place of significance for the treatment of the dead at the time when new agricultural subsistence strategies were being introduced. The funerary practices employed here provide evidence of a complex and multi-stage process which did not require the body to remain intact, but instead involved breaking up the body before intentionally placing it in meaningful places in the landscape.

Chapter Six: An Corran

6.1 Introduction

The site of An Corran is located close to Staffin on the Isle of Skye in Scotland, (Figure 55 and Figure 56). There are a series of shell deposits, identified as a midden, found in a natural rock shelter (Figure 57) and on a ledge extending 6 metres from the base of the cliff-face towards the sea (Saville et al. 2012).

An Corran was first recognised in 1982, later being added to the Sites and Monuments Record and published in the Discovery and Excavation in Scotland journal in 1988 (Wildgoose 1988). It was excavated in 1993 after the instability of the cliff face above became a concern and work was needed to stabilise an access road to the Staffin Slip. The intention of the emergency remedial building work was to cut back the cliff face and rock ledge directly around the shell midden site to level the area off and expand the level of the road (Saville et al. 2012, 6).

Human bones were found in two contexts within the shell midden. As with Carding Mill Bay, a preliminary report was made but no in depth study of the human bones was carried out. Analysis of these bones took place at the National Museum of Scotland and the results are presented here.

6.2 Background to the site

The rock shelter currently lies approximately 20 metres from the sea and it is likely that during the beginning of the Holocene the sea levels would have been much the same as they are today (Saville et al. 2012, 3-4). Around the site is one of the only areas of beach sand on the island of Skye and is located at a point on the coast which is suited to easy access between land and sea.

Preliminary investigation of the site revealed 19th and 20th century pottery indicating that it had been used in recent times for ad hoc “occupation” episodes which included building a fire possibly used for cooking shellfish (Saville et al. 2012).

Figure 55: Location of An Corran shell midden on Skye, Scotland

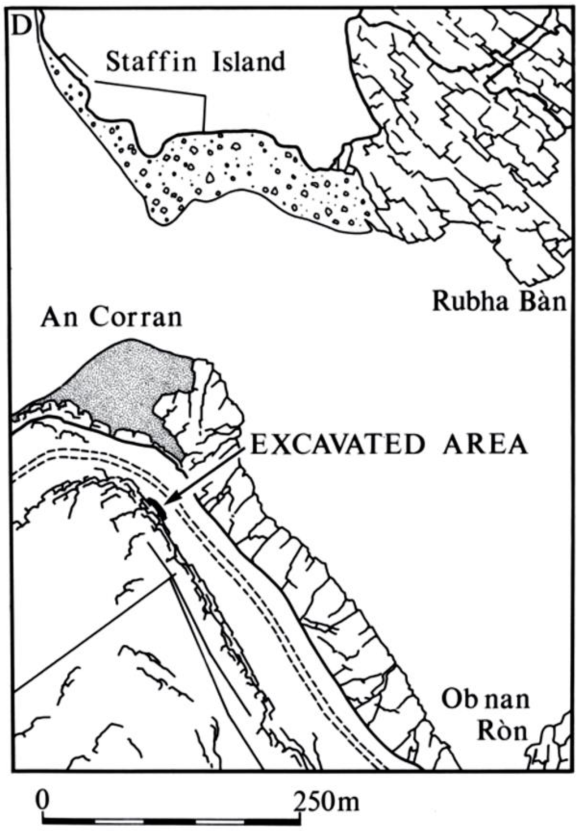


Figure 56: Detailed location of excavated site of An Corran, Scotland (Saville et al. 2012, illustration 2)

Figure 57: Photo showing the rockshelter ledge at An Corran taken in 1988 (Saville et al. 2012, illustration 3)

The fieldwork which took place had to be negotiated prior to development work beginning (Saville et al. 2012). Excavations were carried out between November 1993 and January 1994, for a total of 21 days, but the excavation was disjointed and mainly took place in short stints of a few days as further time was negotiated. The uncertain nature of how much time would be given over to excavation of the site led to an excavation strategy whose main aims were limited and mainly involved gathering enough material to date the site, and recover and record as much data with which to categorise the nature of the site (Saville et al. 2012, 7).

Given that the site was likely to be completely destroyed in the stabilisation work the excavation area was reduced from $5m^2$ (Figure 58), one fifth of the area of the rock ledge, to a more manageable area approximately 2m by 5m (Saville 2011, pers comm.). Some attempt was made to protect the unexcavated archaeological deposits and part of the rock ledge platform was preserved after the significance of the archaeological deposits were recognised and now lie underneath protective layers of sheeting, sand and rock to protect the site from further destruction due to rock fall (Saville et al. 2012, 9) (Figure 59). The original overhanging rock face of the cliff which created the distinctive shelter of the site was completely destroyed (Saville et al. 2012, 9).

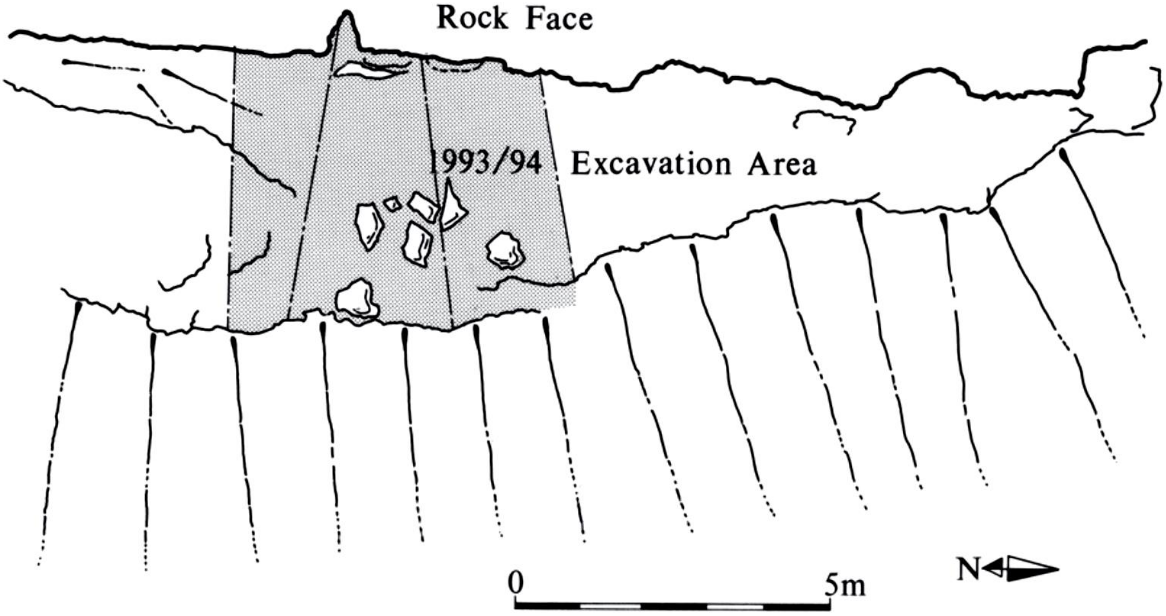


Figure 58: Plan of excavation area at An Corran during the 1993-4 fieldwork (Saville et al. 2012, illustration 9)

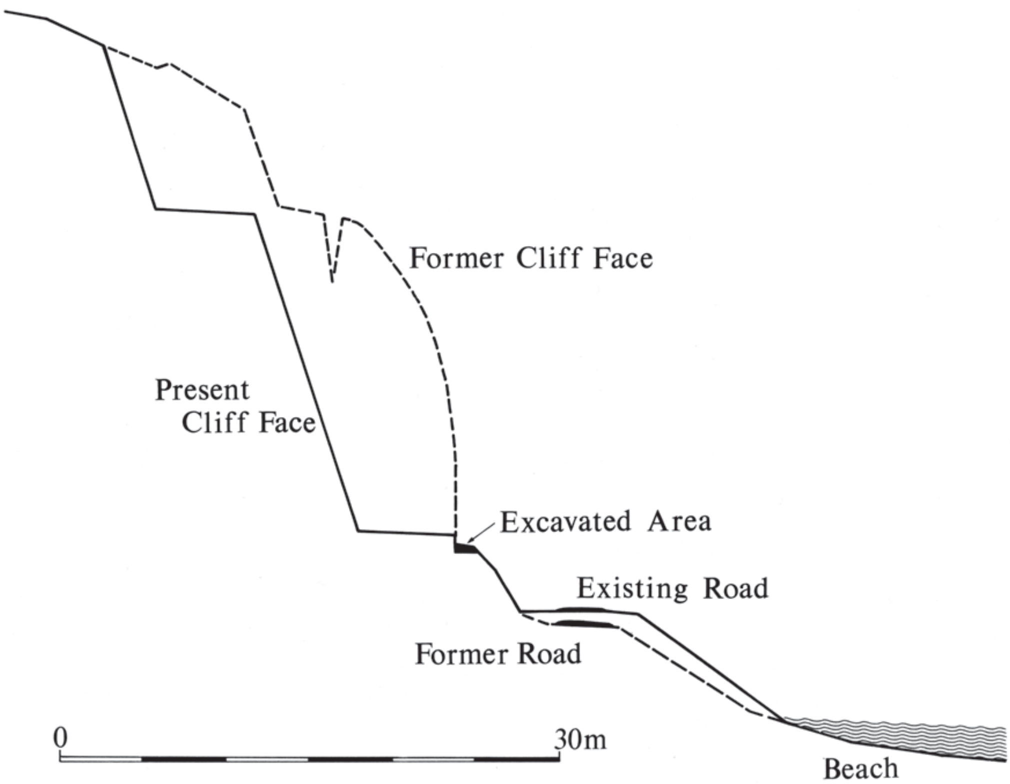


Figure 59: Profile of the location of An Corran shell midden. Showing the cliff face and excavated area prior to remedial action taken on the access road, and the present cliff face and road surface after remedial action was taken (Saville et al. 2012, illustration 12)

6.3 Context of human remains

In total, 41 contexts were identified in the excavated area, with contexts C1-C30 being made up of mainly windblown sand which contained some lenses of burnt material and shell. Contexts C31-C41 were deemed to be Mesolithic as they contained characteristic bone and lithic artefacts (Saville et al. 2012, 92).

C31 was a "black claggy humic layer" (Saville et al. 2012, 92), which incorporated several horizons of shell within it (Figure 60). This context was excavated in 100mm spits which were labelled with the prefix BB. Within C31, spit BB4/5 was recognised as a distinct shell deposit extending beyond C31 and then subsequently labelled as 'C34' (Saville et al. 2012, 92-3) (Figure 60 and Figure 61).

C34 was found at the northern edge of the excavated area and is described as consisting of unconsolidated shell, some of which was crushed (Saville et al. 2012, 93). Animal bones and lithic artefacts were found in this layer, which were typical of the sorts of finds elsewhere in C31. It was recognised that C34 could be evidence of the southern limit of a shell midden which extended north outside of the excavated area (Saville et al. 2012, 93) (Figure 60 and Figure 61).

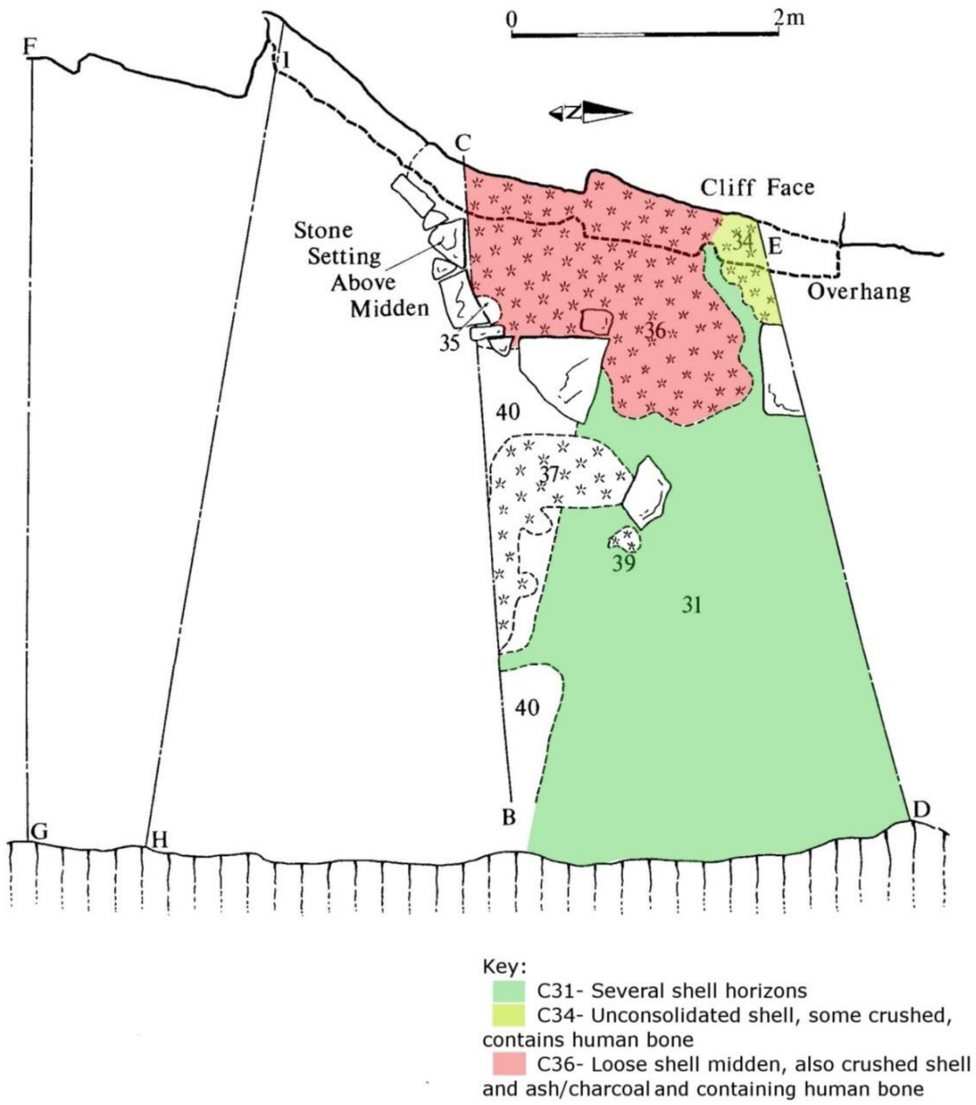


Figure 60: Plan of excavation at An Corran. C31, C34 and C36 shell midden contexts are highlighted. Human remains were found in C34 and C36. (after Saville et al. 2012)

Due to the hurried nature of excavation, C36 (Figure 60) was recorded as one deposit but it has since been identified as three, more distinct, layers. These can be seen highlighted on the section drawing (Figure 62). The base layer of C36 was a thin layer of black organic silt which is now thought to represent a deposit laid down earlier than the rest of C36 (Saville et al. 2012, 93). Directly above this black silt layer was a layer of crushed shell extending from the cliff edge and building in depth from 5cm to 60cm at its greatest depth. The final layer making up C36 is the main part of the deposit. It was described by Saville et al. (2012) as a the "main midden"; a "large, unconsolidated shell midden" which rested against the cliff edge (Figure 62). It is thought that the main unconsolidated shell midden represents a different deposit from the crushed shell layer which it overlies, although this is impossible to say unequivocally (Saville et al. 2012, 93). The main midden was truncated by the intercutting feature C35 but does not appear to continue to the east of C35 as the crushed shell layer does. This main midden within C36 contained many lithic and bone artefacts, animal bone and charcoal as well as human remains.

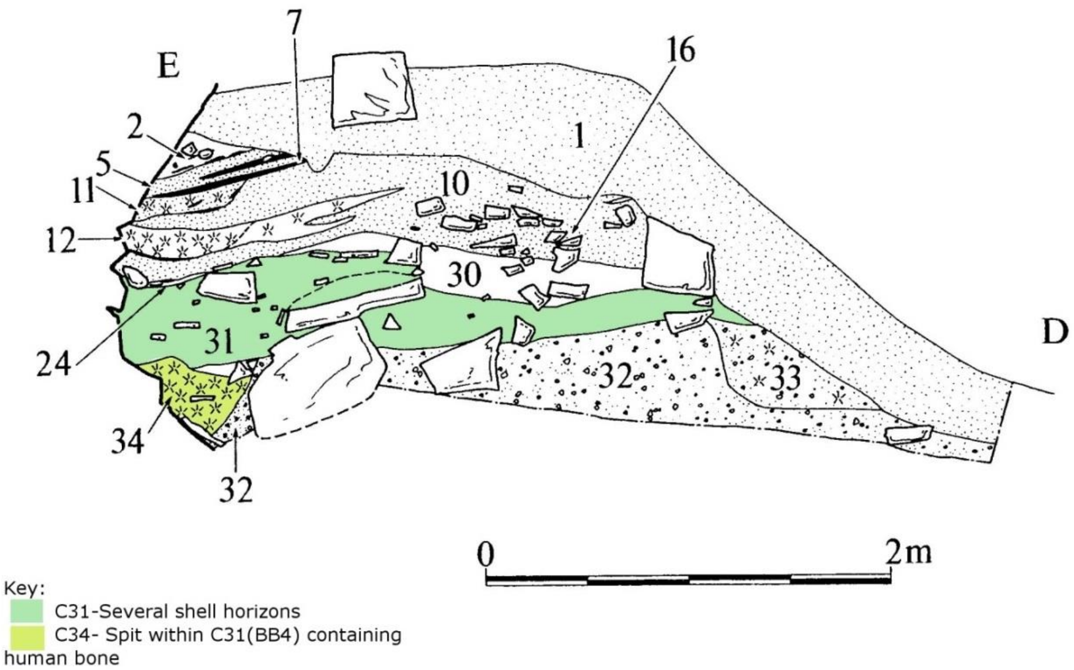


Figure 61: Section D-E from An Corran. Shell midden layers C34 and C31 are highlighted where human remains were found (after Saville et al. 2012)

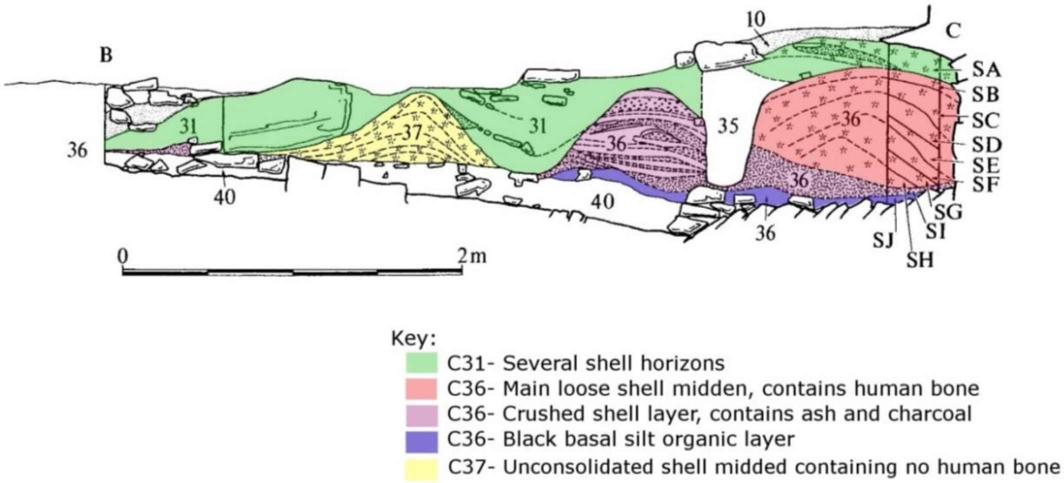


Figure 62: Section B-C of An Corran. Shell middens C31, C36 and C37 are highlighted. Human remains were found in C36 and part of C31 but not in C37 (after Saville et al. 2012)

Human remains were found in two contexts at An Corran: C36 and C34, otherwise known as C31spit BB4 (Figure 60). For the purposes of this study the human remains that were found in spit BB4 of C31 which is part of C34 will be referred to as bones from C34. Human bones were recovered from C34 (or labelled as C31-BB4) but were not found elsewhere in C31. C34 extends beyond the excavated area, meaning that potentially there are more human remains present at the site which have not been excavated.

The other main context containing human remains was C36. Within C36 a 300mm square column was dug, and samples of 15 litre volumes were taken at 100mm intervals with the samples labelled as SA-SJ (Figure 62). Some human remains were found within this column in samples A, C and D, which provide a more fine-grained stratigraphical context for the bones. It should be noted that sample A has been designated as part of C31 (Saville et al. 2012) (Figure 62) which is important because an isolated human bone was located in sample A.

C37 is described as a midden of unconsolidated shell containing animal and fish bones, lithic artefacts and charcoal. No human bones were found within this context which provides an interesting contrast to the two other midden areas within the rock shelter, C36 and C34 which both contain shell. Saville et al. (2012, 93) suggest that the C37 midden could be chronologically distinct from the other shell midden layers at the site but the exact chronology is unclear. The lack of human remains within C37 might be significant in the interpretation of the site, as not all middens were deemed suitable for the placement of human remains. However, this type of consideration should be supported by radiocarbon dates to assess the contemporaneity, or lack of, of the C37 midden with the others at the site before any in depth discussion is appropriate. Unfortunately, there have been no radiocarbon dates taken from C37 which makes this type of discussion limited.

6.4 Dates

There are 18 radiocarbon dates from An Corran (Saville et al. 2012), five of which have been taken directly on human bone, the rest being on animal bone and bone tools (Table 17). Calibrated radiocarbon date distributions from the site arranged according to context (Figure 63) show that the common assumption that uppermost contexts are younger is not valid at this site. The date of 336cal BC- 78cal AD from a roe deer bone point (AA-29312) found in SH the bottom-most sample of the column cut into C36 (Figure 62), provided an anomalously late date for the site which has been interpreted as evidence of the mixing of the layers in antiquity (Saville et al. 2012, 82). All of the animal bones seem to be securely dated within the Mesolithic except from the pig phalanx (AC0675) which was dated to much later in the 2nd millennium BC. The tools made from animal bones are however much more sporadically dated with some as early as the 7th millennium BC (eg. AC0713, AC0178, AC0132, AC0143) but others (eg. AC070, AC0076 and AC0052) dating to the 3rd millennium BC.

Radiocarbon dates obtained on human remains from An Corran were all taken from adult remains. The human remains all have post 4000 cal BC (i.e. Neolithic) dates but the shell middens themselves are thought to be very clearly the result of Mesolithic occupation based on both the dating of the artefacts and the animal bone found within the middens suggesting that Neolithic burial practices here involved placing human remains into earlier Mesolithic middens.

If contexts C34 and C36 are taken to be distinct deposits (Meiklejohn 2014 pers comm.) then it can be said that at least two individuals have been radiocarbon dated. However, these human bones are all within a similar calibrated range (Figure 63 and Table 17) and therefore cannot be used to support the view that deposition of human remains in C34 and C36 occurred in two distinct episodes.

Lab code.	Context number	Catalogue number	Material	δ C13	Radiocarbon age BP	2 sigma cal BC	Source
OxA-14752	C36	AC0178	bovine radius	-22.0	7595 $^{+}/_{-}$ 50	6588-6378	(Milner and Craig 2009)
OxA-4994	C36 (base)	AC0044	red deer bevelled tool	-21.6	7590 $^{+}/_{-}$ 90	6607-6247	(Saville and Miket 1994)
OxA-14751	C36	AC0132	bovine lumbar vertebra	-22.3	7555 $^{+}/_{-}$ 45	6480-6264	(Milner and Craig 2009)
OxA-14753	C34	AC0713	bovine rib	-21.6	7525 $^{+}/_{-}$ 45	6462-6256	(Milner and Craig 2009)
OxA-13551	C36	AC0143	pig rib	-21.5	7485 $^{+}/_{-}$ 55	6440-6240	(Milner and Craig 2009)
AA-27746	C41	AC0678	ruminant long bone (burnt)	-22.8	6420 $^{+}/_{-}$ 75	5517-5225	(Saville 1998)
AA-29316	C36	AC0006	red deer bevelled tool	-20.6	6215 $^{+}/_{-}$ 60	5312-5018	(Saville 1998)
AA-29315	C36	AC0026	red deer bevelled tool	-21.3	5190 $^{+}/_{-}$ 55	4229-3807	(Saville 1998)
OxA-13549	C31-BB4	AC0627	human navicular tarsal	-19.4	4650 $^{+}/_{-}$ 55	3632-3196	(Milner and Craig 2009)
OxA-13552	C36	AC0458	human cervical vertebra	-19.9	4535 $^{+}/_{-}$ 50	3488-3035	(Milner and Craig 2009)
AA-27744	C31-BB4	AC0628	human metatarsal	-20.2	4405 $^{+}/_{-}$ 65	3335-2903	(Saville 1998)
OxA-13550	C31-BB4	AC0632	human lumbar vertebra	-20.5	4360 $^{+}/_{-}$ 55	3316-2884	(Milner and Craig 2009)
AA-29311	C31	AC0076	red deer bevelled tool	-23.3	4175 $^{+}/_{-}$ 60	2896-2581	(Saville 1998)
AA-29314	C31	AC0052	ruminant bevelled tool	-20.6	3975 $^{+}/_{-}$ 50	2621-2301	(Saville 1998)
AA-27743	C36	AC0270	human ulna	-24.0	3885 $^{+}/_{-}$ 65	2566-2146	(Saville 1998)
AA-29313	C38	AC0070	red deer bevelled tool	-23.9	3660 $^{+}/_{-}$ 65	2274-1881	(Saville 1998)
AA-27745	C41	AC0675	pig proximal phalanx	-26.0	3120 $^{+}/_{-}$ 60	1517-1219	(Saville 1998)
AA-29312	C36-Col 1 Sample H	AC0102	roe deer bone point	-22.0	2045 $^{+}/_{-}$ 60	336cal BC – 78cal AD	(Saville 1998)

Table 17: Radiocarbon dates from An Corran, in chronological order, with dates on human remains highlighted in grey

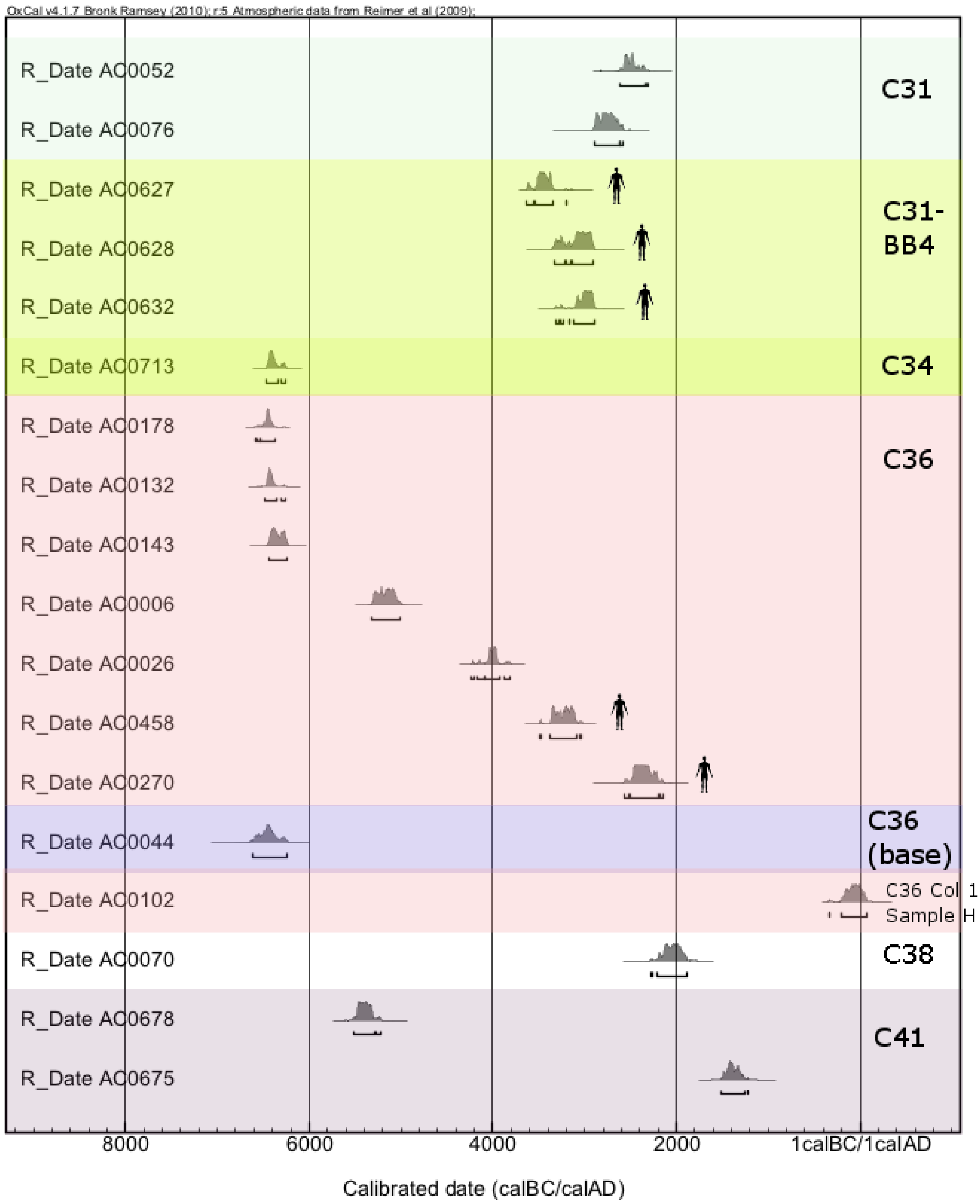


Figure 63: Calibrated radiocarbon date distributions from An Corran, arranged by context, shown to 95.4% confidence. Calibrations are new, using Oxcal 4.2 (Bronk Ramsey and Lee 2013). Dates obtained from human remains are indicated by the human silhouettes, all other dates were obtained from faunal remains.

It is likely that one human ulna specimen, AC0270 (Figure 64), represents a later inclusion into the midden with a calibrated date range at least 300 years younger (2566-2146cal BC) than the other bones tested in either context and suggests that some use of the midden for funerary processes occurred in the Early Bronze Age period (Saville et al. 2012, 80).

Figure 64: Human ulna AC0270 from An Corran, which dates to the early Bronze Age

6.5 Published analysis of the An Corran human remains

The osteological report for An Corran states that there is a total of 39 bones and seven teeth identified as human (Bruce and Kerr 2012) however, some of these have not been securely identified as human as they are too fragmentary, and at least one has subsequently been identified as pig through stable isotope analysis (Milner and Craig 2009) suggesting further examination of the human bones was necessary.

6.5.1 Minimum number of individuals, ageing and sex

According to the original report (Bruce and Kerr 2012) there is a MNI of five represented: two children, a late teenager and two adults; one of no more than 35 years of age and one over 40 years of age identified by osteoarthritis in the cervical spine.

Bruce and Kerr's discussion of the teeth, all of which are non-adult, includes crown dimensions where the tooth is complete enough to allow this (Bruce and Kerr 2012). This is standard practice in the osteological recording of human remains (Buikstra and Ubelaker 1994) but in the An Corran bone report these dimensions have then been used to make assessments of the sex of the child (Bruce and Kerr 2012). They state that the tooth measurements indicate that all of the tooth specimens, apart from AC0909, are likely to be from the same individual; a female aged 5 years +/- 9 months. The specimen AC0909 is then described as belonging to a young male infant aged 9 months to one year (Bruce and Kerr 2012). However the methodology applied in this thesis concluded that juvenile human remains are not suitable for sex estimations due to the fact that they have not yet gone through puberty and developed the characteristic differences attributed to male and female skeletons (White et al. 2011). Also worth noting is the degree of uncertainty associated with assessing sex from tooth dimensions (Mays and Cox 2006, 123; White and Folkens 2005, 387; White et al. 2011, 415) where sexual dimorphism can vary by only a millimetre and really needs to be carried out only where robust comparative material for the populations being studied is available, which is not the case with the An Corran remains. The relative nature of assessing sex from dental measurements and the widely accepted fact that juvenile skeletal remains are unsuited to sex determination means that the conclusions presented by Bruce and Kerr (2012) should be treated with caution.

6.5.2 **Pathology**

Assessment of the pathology discusses the osteoarthritis present in the cervical vertebra (AC0458) which displayed pitting and eburnation on the auricular surface with some possible nerve compression due to the encroaching of the right nerve passage (Bruce and Kerr 2012). It was also noted by Bruce and Kerr (2012), that there was some degenerative change on a phalange (AC0912) and there were enthesopathies formed on a proximal ulna (AC0270) which may be related to advanced age or strenuous activity during the individual's lifetime.

6.6 New analysis of the human remains at An Corran

New analysis of the An Corran remains has been undertaken for the purposes of this study according to the methodology specified in Chapter 2. This new analysis focussed only on those skeletal elements which have been definitively identified as human, resulting in a smaller sample size of 27 specimens than the 39 and seven teeth in the original bone report and a full inventory is provided in Appendix 7. The bone fragments which had previously been identified as possibly human ("?human") were carefully assessed to identify any stand-out features particularly taphonomic indicators. However, none were observed on the ?human bone and thus no further detailed analysis of these bones was deemed necessary for this study.

6.6.3 **Minimum number of individuals and ageing**

The human bones were all disarticulated specimens and mostly fragmentary in nature. Of the twenty seven bones in the assemblage, this study supports the estimation from Bruce and Kerr's report (2012) that there is likely to be an MNI of five. This estimate is based on the representation of skeletal elements within the assemblage combined with the age profiles of the remains (Roberts 2009, 120). Due to the fact that radiocarbon dating does not allow C34 and C36 to be securely dealt with as distinct depositional episodes the MNI will not be refined to account for the bones found in these contexts being from distinct individuals, a possibility suggested by Meiklejohn (2014 pers comm.). This study will therefore deal with the human remains collectively from both contexts.

Figure 65: Three 3rd metatarsals from An Corran. Left to right in picture: AC0629 (right), AC0628 (left), AC0631 (left)

Three 3rd metatarsals present in the An Corran assemblage, two left and one right (Figure 65) identify at least two individuals due to repeated skeletal elements. However when combined with the age profiles of the remains, a method suggested in Roberts (2009, 120), a larger MNI of five, or possibly six, individuals is suggested (Table 18).

Individual	**Age indicated**	**Reason for age estimation**
1	Adult	Repetition of left 3rd metatarsal AC0628 and AC0631 indicating at least 2 adults (Figure 65).
2	Adult	Repetition of left 3rd metatarsal. AC0628 and AC0631 indicating at least 2 adults (Figure 65).
2a	?Old adult	Some degenerative joint disease (DJD) displayed in phalanx (AC0912.5) and cervical vertebra (AC0458) See Figure 66. But this could be part of same skeleton as either 1 or 2 as DJD affects different areas of body.
3	Adult	Ulna AC0270 has been C^{14} dated to 2566-2146 cal BC; at least 300 calibrated years later than other deposits.
4	Infant c. 9 mo. +/- 3 mo.	Based on tooth development of deciduous incisor (AC0909) as defined by Buikstra and Ubelaker (1994, 50-53). See Figure 68.
5	Juvenile c. 5 yrs +/- 16 mo.	Based on tooth development of permanent premolars (AC0683 and AC0908) as defined by Buikstra and Ubelaker (1994, 50-53). See Figure 69.

Individual	Age indicated	Reason for age estimation
?6	Juvenile c. 4 yrs +/- 12 mo.	Based on root reabsorption of deciduous incisor (AC0910) and the developing canine crown (AC0639) as defined by Buikstra and Ubelaker (1994, 50-53). See Figure 70 and Figure 71.

Table 18: MNI at An Corran based on age profiles

It is possible that individuals number 5 and ?6 (Table 18) are the same person due to the large error margins of the estimated ages caused by the imprecision of the ageing methods associated with commingled remains. Whilst skeletal ageing is generally more accurate amongst juvenile remains, because tooth development is more closely related to chronological age than the development of other skeletal elements (Roberts 2009; White and Folkens 2000; White and Folkens 2005), it can be imprecise because individuals develop in different ways and at different rates (White and Folkens 2000, 341). In order to increase the precision of ageing, assessment of all aspects of a skeleton and the dentition is preferred (White and Folkens 2000, 342; Ubelaker 2008, 46) and an atlas method of assessing age using the teeth, such as the one applied in this analysis (taken from Buikstra and Ubelaker 1994, Figure 24), can increase the precision of ageing (Liversidge 1994). However based on the error margins for each of these age estimations and the inability to assess the more complete skeletons for ageing characteristics it cannot be securely concluded that there were more than five individuals present.

6.6.4 Sex

The fragmentary nature of the An Corran assemblage meant that diagnostic skeletal elements such as the cranium and pelvis did not survive. It was possible to obtain the glenoid fossa width of the scapula (AC0283), which measured 20.7mm, and is therefore within the female range (Bass 2005, 123). However determination of sex using metrical variation should not be used unquestioningly as the value of this technique depends on the sample population (Mays and Cox 2006, 120-1). Also in this case the glenoid fossa is not quite complete, with a small portion missing on one edge, which makes any measurement inaccurate and should not be used as the sole basis for sexing. It is therefore only possible to say that the An Corran assemblage is difficult to sex, with there being one possible female present.

Figure 66: Cervical vertebra (AC0458) from An Corran, inferior view. Showing osteophytes and pitting indicative of DJD and indicating older age.

Figure 67: Lumbar vertebra (AC0632), superior view. Showing no signs of DJD.

Figure 68: Deciduous incisor (AC0909), labial view. Root development suggests infant aged c. 9 months.

Figure 69: Mandible (AC0683) showing deciduous 1st premolar and developing permanent molar, apical view. Suggests age of c. 5 years.

Figure 70: Developing permanent molar (AC0639), labial view. Showing development indicating age of c. 4 years.

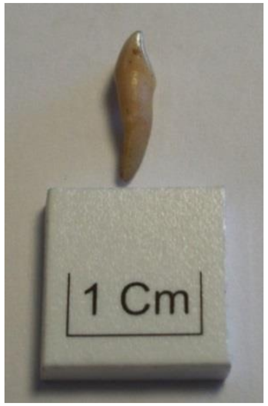


Figure 71: Deciduous mandibular incisor (AC0910), mesial view. Root reabsorption suggests juvenile age of c. 4 years.

6.6.5 **Pathology**

There was little pathology recorded on the skeletal remains, with only some evidence of DJD, indicative of osteoarthritis in the form of osteophyte formation and eburnation, being present on three of the bones. A cervical vertebra (AC0458, Figure 66), and a proximal ulna (AC0270, Figure 64), showed osteophyte formation and pitting on the joints which indicates degeneration of the cartilage (White and Folkens 2005, 424) and a phalanx (AC0912.5) showed a polished shiny surface, or eburnation, of the proximal facet indicative of friction between bones due to cartilage loss (White and Folkens 2005, 421). The presence of DJD can suggest an individual of older age caused by bone changes and wearing due to repeated activity during their lifetime (Roberts 2009, 174). However, it is impossible to assess how the individual's lifestyle affected their likelihood of developing DJD; someone starting a strenuous activity at a young age and doing it often will likely show more bone response than someone of greater age who did this activity less often (Roberts 2009, 174).

6.6.6 **Taphonomic indicators**

One specimen, a metacarpal (AC0117), did show signs of cracking on the surface of the bone indicative of weathering but it was only minor and cannot be relied upon as definite evidence of sub-aerial exposure of bone. None of the other bones showed any sign of weathering, root or fungal activity, or animal gnawing all of which suggests that the bones were probably incorporated into the midden before such modification could take place. There is a possibility that the ulna (AC0270) was broken peri-mortem (around the time of death) due to the longitudinal nature of the break (Figure 72) and the clean edge which suggests that the break occurred on "green bone" (bone retaining its organic component) (Loe 2009, 267; White and Folkens 2005, 51).

Figure 72: Ulna (AC0270) from An Corran. Showing longitudinal fracture which might have occurred peri-mortem.

6.6.7 **Skeletal elements present**

The osteological report states that "virtually all parts of the skeleton were represented" (Bruce and Kerr 2012, 44) but given the fact that they represent a MNI of 5 the human remains are small in number. It does seem that most areas of the body are represented; 7 skull elements, 2 vertebral column elements, 2 from the rib cage, 3 bones from the upper limbs, 1 part of the lower limbs, and 11 elements from the extremities. A complete inventory of the human remains found is provided in Appendix 7.

However, although the bones appear to be from all areas of the body, this is by no means indicative of a full inhumation in the shell midden. Not only are the remains very fragmentary in nature but there are some striking omissions from the assemblage (Figure 73). Most notable is that there are no cranial fragments present at all, although there are some pieces of mandible and quite a few teeth, all of which come from non-adults.

The assemblage at An Corran contains skeletal elements from all stages of the disarticulation process illustrated by;

- part of a scapula (AC0283) which would be the first element expected to be completely disarticulated from the skeleton
- ribs (AC0118 and AC0912.1) and a lumbar vertebra (AC0632) which do not disassociate completely until the later stages of decomposition
- bones from the extremities (such as AC0628, AC0625 and AC0117) which commonly disarticulate in the middle stages of disarticulation

which suggest that whole bodies were taken to the site where skeletonisation and disarticulation occurred.

There is a distinct lack of any pieces of cranium despite it being fairly easily recognisable as a human skeletal element (Haglund 1997). Even the bones from An Corran which have been categorised as "?human" show no elements which are cranial fragments. The majority of the possible human skeletal elements are rib fragments or very small pieces of bone which might be parts of the long bones. It is therefore fair to assume that the missing cranial elements are not due to misidentification of the bones.

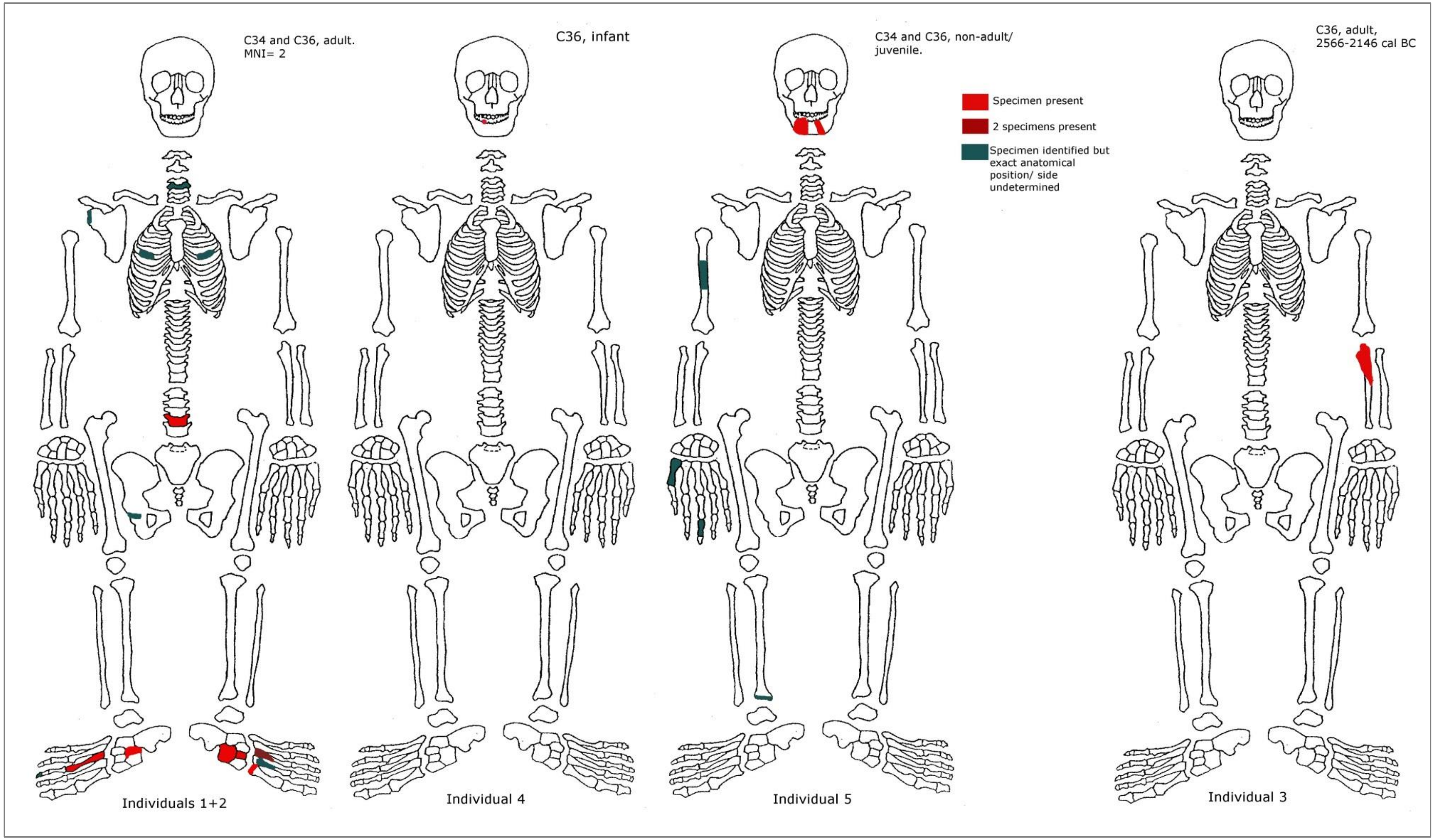


Figure 73: Skeletal inventory diagram showing the bones found at An Corran belonging to a MNI 5.

However, there is presence of fragments of mandible within the assemblage, and this supports the argument that whole bodies were placed at the site early in the disarticulation process which indicate that the mandible disassociates from the cranium relatively early on in the process (Andrews and Cook 1985; Hill 1979; Hill and Behrensmeyer 1984).

There are only two small pieces of long bone present; a fragmented shaft which is probably humerus (AC0615) and a small unfused proximal epiphysis of a tibia (AC0912.2) (Figure 73). A proximal end of the ulna (AC0270) is also present but this has been dated in the Bronze Age and is therefore representative of a distinct phase of occupation, not relevant here. It is possible that the humerus and tibia were more complete when they were placed in the shell midden and have been broken down due to trampling or other taphonomic processes. The missing part of these bones may not have been recovered as they may be present in unexcavated parts of the site. There is also the possibility that they were so fragmentary that they were not recognised as human during the post excavation analysis. There are some possible long bone fragments in the "?human" bones but it is not clear if any of these relate to the humerus or tibia identified.

Given that there is good evidence to suggest that entire bodies were present at An Corran due to the representation of skeletal elements which disarticulate in the early stages of decomposition, the lack of representation of large, identifiable parts of the skeleton such as the cranium, long bones and pelvis (Figure 74), which are expected to survive well (Merbs 1997), points towards the interpretation that certain skeletal elements were intentionally removed from the site as part of a multi-stage funerary process.

Figure 74: Pelvis (ischial acetabulum) AC0912.3, the only piece of pelvis found at the site

Supporting this hypothesis of removal of certain parts of the body is the presence of smaller bones such as the extremities. There were eleven hand and foot bones recovered out of twenty seven skeletal elements. In a complete skeleton there are proportionally more bones in the hands and feet (106) than larger identifiable bones such as the skull and long bones (13). It would be expected that there would be numerically more of them present in a full assemblage but due to taphonomic processes it is more likely that these would not survive archaeologically (Nilsson Stutz 2003). Therefore, the presence of a large number of hand and foot bones at An Corran is suggestive that human practice caused their deposition at the site rather than preservational bias.

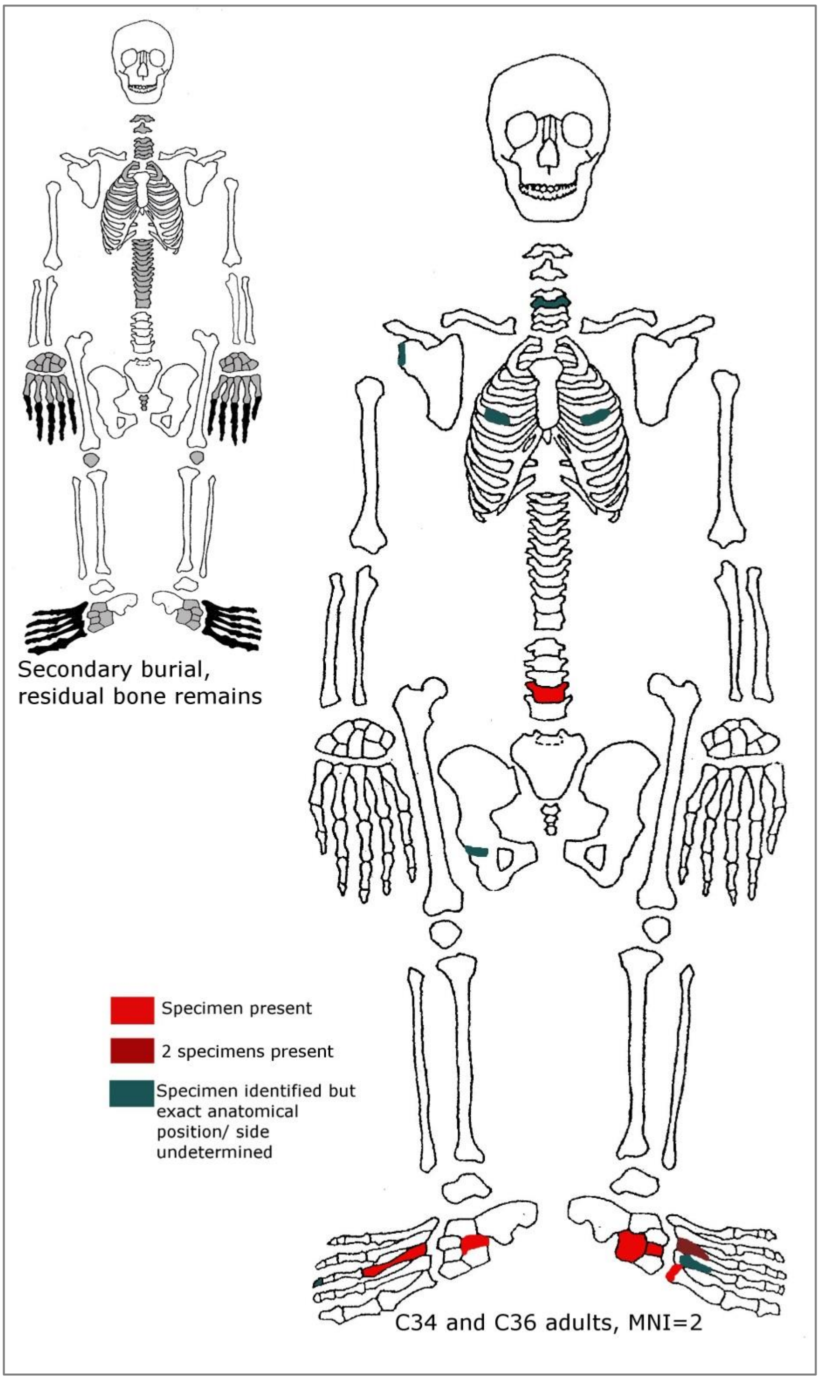


Figure 75: Comparison of skeletal inventory diagram of MNI 2 adults from An Corran with the possible profile of residual bone resulting from a secondary burial rite

Comparison of the adult remains from C34 and C36 at An Corran with the potential skeletal profiles suggests that they are indeed most closely aligned with profile 6, elements expected in a secondary burial profile (Figure 75). Specifically the An Corran remains are most like the pattern of elements which might be left behind after skeletonised remains are collected for secondary treatment. The trunk area is likely to be represented, as it is one of the last parts of the body to disarticulate and extremities are expected as they can easily become incorporated into the midden before any collection or selection of bones might have taken place. The complete lack of cranial remains (except a juvenile mandible) implies that some intentional removal of selected body parts took place probably as part of a burial practice which involved disarticulating the body. Due to lack of weathering or animal gnawing observed on the bones it can be concluded that there was not an extended period of excarnation of these remains. Instead, it is possible that the decomposing body was protected in some way to prevent animal scavenging and the bones were collected for secondary processing shortly after skeletonisation occurred. The residual bone remaining then became incorporated into the midden quickly after, perhaps as part of the secondary treatment itself.

6.7 Burial processes at An Corran

The lack of stratigraphical integrity and small numbers of human bones found at An Corran makes it difficult to draw firm conclusions about the exact nature of burial practices demonstrated at the site but it is likely that there was some form of intentional treatment of the dead occurring at the site rather than chance incorporation into the midden through natural taphonomic processes.

It appears that whole bodies were present at the rock shelter site indicated by the presence of bones which disassociate from the corpse at an early stage of decomposition, like the mandible and scapula. The bodies were probably then laid out on the shell midden at the back of the rock shelter, close to the cliff edge, where they were protected from the worst of the elements and weathering effects, in order for the flesh to decompose and be removed from the bone. As this process occurred it is possible that some skeletal elements became incorporated into the shell midden as they became detached from the body.

When most of the flesh had been removed from the bones certain identifiable parts of the skeletons were collected from the shell midden and taken elsewhere, possibly to be subject to secondary funerary practices. The elements which were particularly important to these on-going rituals were the crania and long bones, resulting in a distinct paucity of these elements being recovered at An Corran.

Chapter Seven: Havnø

7.1 Introduction

Havnø midden is located in north east Jutland, Denmark (Figure 76). It is now an inland site but during the Mesolithic and Early Neolithic it would have been a small island in the Mariager Fjord (Andersen 2008, 3).

Havnø shell midden was first discovered in 1894 but was not subject to any further investigations until 2004 when Professor Søren H. Andersen began excavations (Andersen 2008, 3). He carried out fieldwork between 2004 and 2012 during which a large trench was cut through the middle of the midden (Figure 77) in order to assess the overall stratigraphy of the site and several large square trenches were dug across the midden and to the rear of the midden to look for evidence of settlement and occupation (Andersen 2008, 3).

Human bone was found in various parts of the midden and during a season excavating on site I was invited to examine it. The bone was examined using the protocols set out in Chapter 2, as well as refitting analysis being conducted. In addition, stable isotope analysis was undertaken for another PhD project by Harry Robson. This stable isotope data was also used for this research project in order to further refine the MNI for the assemblage and then in turn aid in selection of bone for radiocarbon dating. Finally, a collaboration was initiated with another PhD student in Sheffield, Tom Booth, to examine degradation processes in human bone. This chapter presents the details of the site and excavation, the analysis of the bones, and the associated scientific analyses.

7.2 The site

The site is a large oblong midden approximately 100m in length, between 25m and 27m in width and containing shell deposits up to 90cm deep (Andersen 2008, 4). It is thought that the midden was built up by gradual accumulation over a period of around 1300 radiocarbon years with individual deposits of shells being visible in the profile (Andersen 2008, 4). The midden is largely made up of oyster, cockle, mussel and periwinkle shells with two distinct shell horizons which correspond to the late Mesolithic and the transition period to the early Neolithic (Figure 78). The lower, late Mesolithic layer is dominated by oyster and is a light white-grey colour and contains large whole shells. Contrastingly, the early Neolithic layer above is darker in colour due to high charcoal content and contains notably fewer oyster shells. The shells that are present in the Neolithic layer are predominantly crushed rather than whole (Andersen 2008, 4). Cultural occupation evidence is present in the form of hearths, charcoal and cooking stones along with flint debris, faunal bone and sherds of Ertebølle (late Mesolithic) and Funnelbeaker (early Neolithic) pottery (Andersen 2008, 4).

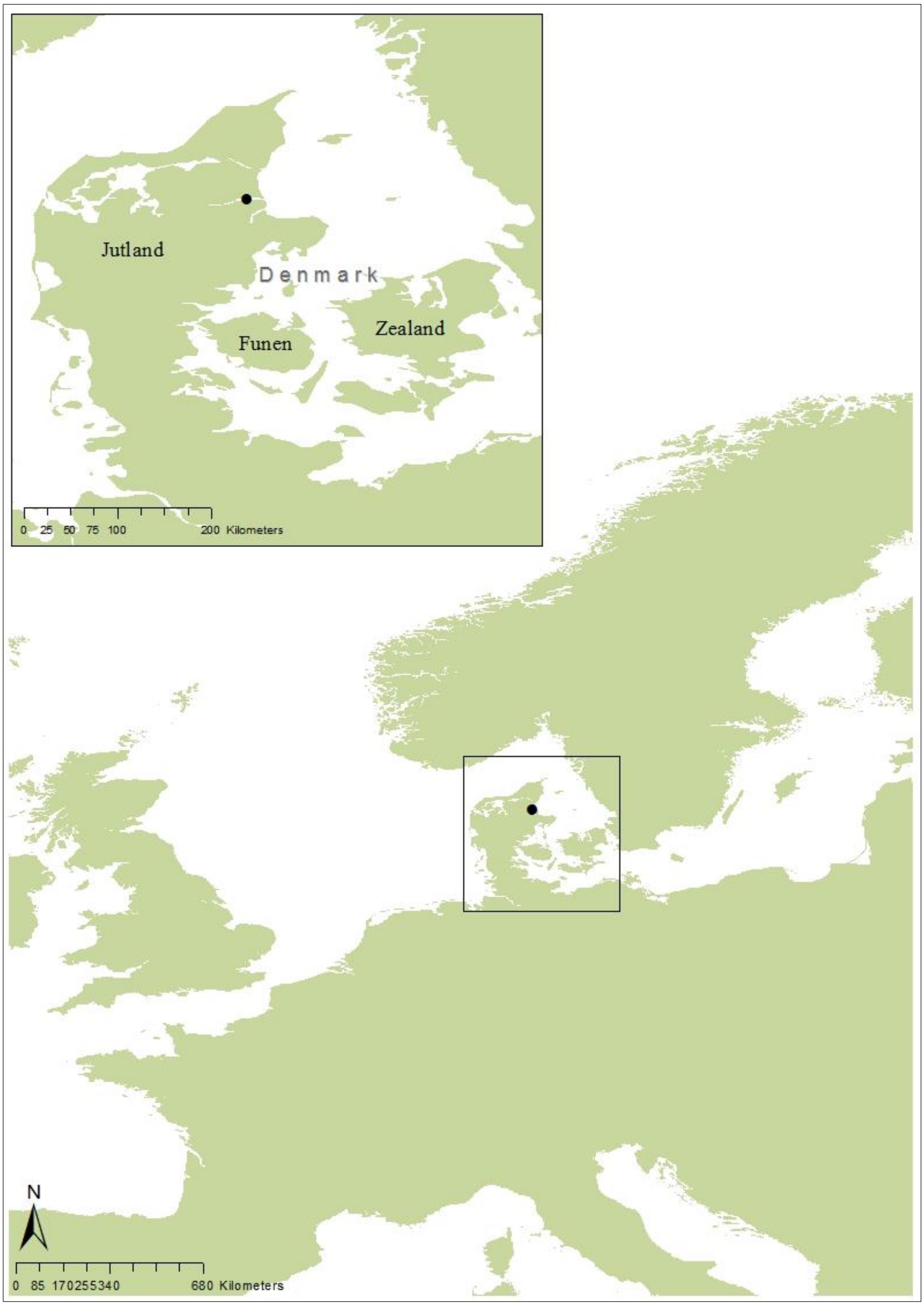


Figure 76: Location of Havnø shell midden site in Jutland, Denmark

Figure 77: Long section trench cut north-south through the Havnø midden, viewed from the south during the 2011 excavation season

Figure 78: Column section cut into Havnø midden showing the characteristic light grey whole oyster layers of the Mesolithic contrasted with the darker crushed shell layers of the Neolithic

It is thought that occupation of the midden occurred in short visits throughout the year to exploit the abundant local resources: oysters in March/April, eels in late summer, and birds in summer and winter (Andersen 2008, 5). Fish hooks and eel and flatfish bones indicate fishing taking place at the site while bones of swans, duck, geese and cormorants indicate exploitation of birds (Andersen 2008, 5). There are also bones of grey seal and terrestrial mammals such as wild boar, red and roe deer, elk and aurochs, and in the Neolithic layers cattle, pig and sheep/goat (Andersen 2008, 5).

7.3 Osteological analysis

A total of 50 human skeletal specimens have been subject to primary analysis as part of this research consistent with the methodology outlined in Chapter 2. These have not been previously studied and therefore the analysis presented here constitutes the first osteological study of the remains. This analysis was carried out in three parts; an initial assessment of the majority of the human remains assemblage was undertaken during a research visit to the Havnø site during the excavation season in August 2011, after which a further phase of analysis was possible at the University of York while the bones were on loan by kind permission of Professor Andersen. The final stage of research into the Havnø remains took place during a visit to the Zoological Museum, Copenhagen in February 2012 to obtain samples for ZooMS analysis and during which time some newly identified human remains were available for study. It was not possible to remove the identified human specimens examined in Copenhagen for further analysis alongside the human bones on loan in York.

The human remains assemblage was separated from the faunal bone by Kurt Gron, a PhD student working on faunal remains in Danish shell middens. The excavation strategy employed at the site stipulated that any bone fragment of possible identifiable morphology be spatially plotted to the nearest 1cm^2 in three dimensions using a theodolite. Each find of this sort was allocated a unique two, three or four letter find "identifier" (ID), for example *ABC*. All identifiable finds were recorded in on-site finds books which recorded the find ID, co-ordinates and details of the find and matrix in which it was found. Contexts were also identified and allocated IDs in the form of letters in a similar way. The two-dimensional location, level and find ID were also recorded on the excavation plans.

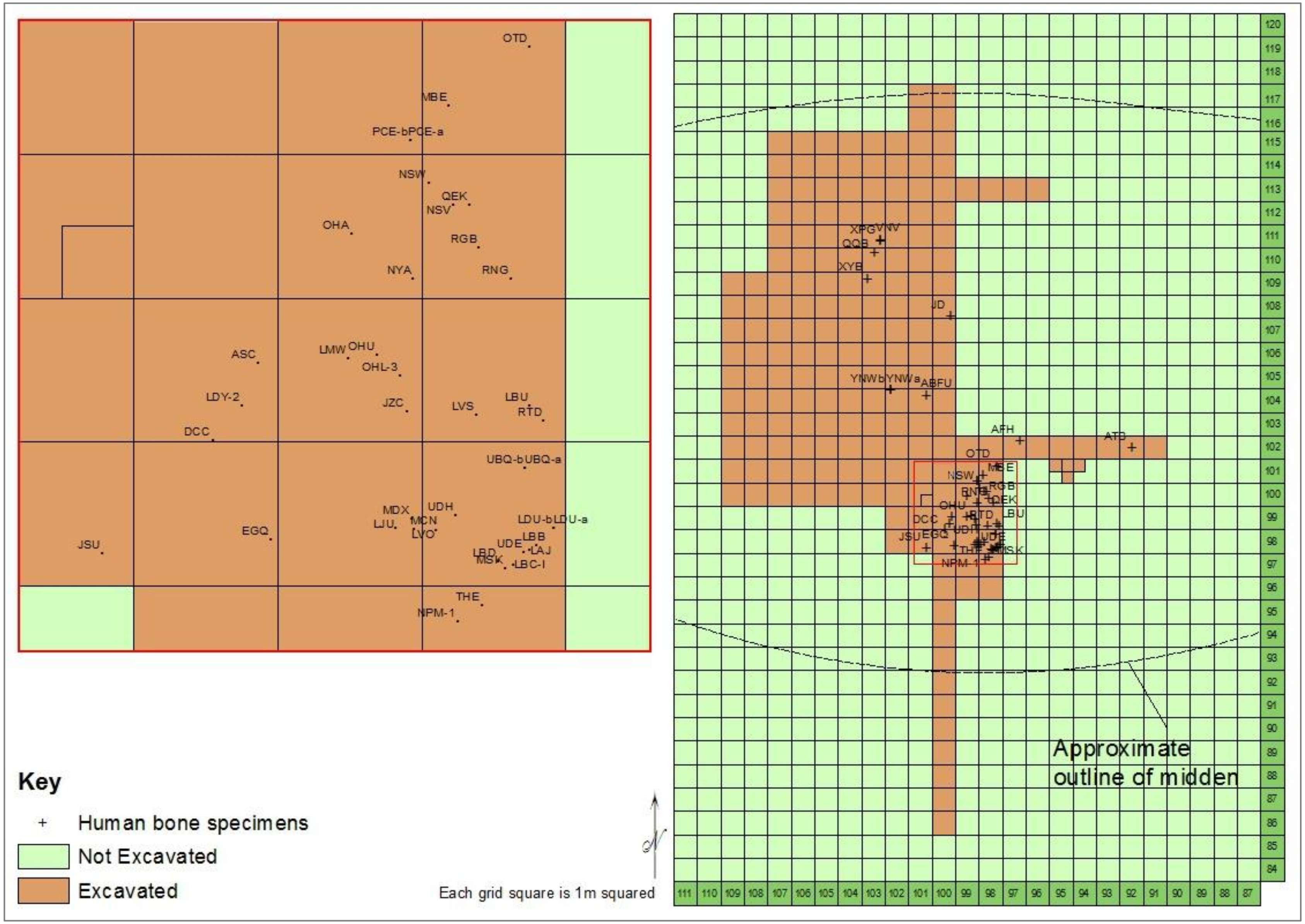


Figure 79: Spatial distribution of human remains from Havnø shell midden

The Havnø human remains were found in a good state of preservation however, they were disarticulated and fragmentary. There is a notable absence of ribs and vertebrae from the assemblage but with most other skeletal elements being represented, although they are by no means indicative of a complete skeleton. A full inventory of the human remains is provided in Appendix 8. The spatial distribution of the skeletal remains (Figure 79) shows that the majority of the human remains found at the site were grouped together in the southern part of the midden with a few scattered remains located in the northern part of the midden.

7.3.1 Age and Sex

Ageing of the skeletal specimens was limited due to the fragmentary nature of the remains and the lack of secure diagnostic elements of the skeleton. However, five juvenile cranial fragments were identified, notable by their smaller size and thin bone profile providing an age estimate of 4-6 years old (Figure 80).

Figure 80: Example of a juvenile cranial fragment found at Havnø, right eye orbit of a juvenile aged 4-6 years (specimen VNV)

An adolescent individual was identified by a radius which has been broken into two parts across the medial portion of the shaft (Figure 81). The proximal epiphysis is unfused but the distal epiphysis shows partial union; based on skeletal epiphyseal fusion (Buikstra and Ubelaker 1994, Figure 20) this indicates an age of c. 14 years, putting it in the adolescent age category.

Figure 81: Specimen JD from Havnø; adolescent radius showing unfused epiphyses and a break along the medial shaft

The remaining specimens were all classified as "adult" of unknown specific age. A mandible which contained 9 teeth still in situ in the jaw (Figure 82) has incisor wear comparable to stage 3 in Smith's 1984 scoring system (cited in Buikstra and Ubelaker 1994, 52) showing some wear and exposure of dentin in the incisors. The presence of wear on the teeth confirms that the specimen belongs to an adult individual but there is little wear on the premolars, suggesting that the individual was not of advanced age. It is not possible to provide a more precise age estimate based on the lack of molars which provide more accurate dental ageing criteria (Buikstra and Ubelaker 1994, 52).

Figure 82: Specimen YNW-a from Havnø; adult mandible with 9 teeth in situ

DJD was evident in a number of specimens (Table 19) which might indicate that an individual of older age is present, although, as mentioned previously, the link between DJD and advanced age is not always secure as lifestyle can affect development of DJD (Roberts 2009, 174).

Specimen	Degenerative Joint Disease (DJD) signifiers
AFH: Ulna, left	Porosity and additional bone formation on proximal epiphysis
THE: 1st metatarsal, right	Porosity and osteophyte formation on head and base
UDE: 1st proximal phalanx, right	Porosity and osteophyte formation on head and base
LBB: talus, left	Eburnation on proximal facet
EGQ: 1st distal phalanx	Porosity and osteophyte formation
NPM-1: 5th phalanx	Distal and intermediate phalanges have fused indicative of pronounced osteophyte formation

Table 19: Presence of degenerative joint disease in the skeletal assemblage at Havnø

7.3.2 Pathology

Pathology present in the Havnø assemblage mainly consisted of the DJD indicators (Table 19). Additionally, some dental enamel hypoplasia, in the form of grooves and pits present on the teeth, was observed on an adult mandible (Figure 82). Dental enamel hypoplasia indicates that the individual underwent a period of dietary stress in the period when their crown enamel was developing (up to the age of c. 7 years (Goodman et al. 1980)).

Two ulnas, each made up of two refitted fragments, were similar in size and shape and both contained osteophytes present in the trochlear notch, see section 7.3.5, suggesting that they could be the same individual.

There is some woven grey bone visible on the anterior surface of the right fibula (LBC-1, Figure 83) indicating active inflammation of the bone at the time of death which might have been caused by trauma or infection (White and Folkens 2005, 318).

Figure 83: LBC-1 with highlighted woven grey bone indicative of trauma or infection active at time of death

7.3.3 Minimum number of individuals

Based on the osteological analysis a MNI of three are evident in the Havnø assemblage; one adult, one adolescent and one juvenile. The juvenile cranial remains possibly all belong to the same individual and the adolescent radius represents another single distinct individual. The adolescent is represented by one radius with unfused epiphyses.

The adult remains may possibly belong to one or two individuals. There are no repeated skeletal elements to suggest more than one individual but the presence of DJD on some of the bones suggests older age which conflicts with the relatively young adult age indicated by the tooth wear analysis of the mandible (Figure 82). The possible presence of two adult individuals in the assemblage is complicated by the fact that DJD can affect different areas of the skeleton at different rates, as mentioned previously (Bridges 1991; Haskin et al. 1995; Roberts 2009). The majority of the instances of DJD present in the Havnø assemblage occur in the feet, which means that this individual may have been particularly badly affected in this area of their body but not in others. Haskin et al. (1995) discuss the fact that DJD affects the feet in 40% of cases and may be due to excessive loads or repetitive activities. Given this knowledge of site specific DJD and the lack of repeated skeletal elements within the adult assemblage it could be misrepresentative to conclude that there were two adult individuals and instead it is concluded that the osteological MNI is three.

7.3.4 Taphonomy

No specific taphonomic markers were observed on the human remains from Havnø.

7.3.5 Refitting analysis

Refitting analysis was conducted on several bones in order to further understand the relationship between the remains in the midden. Refitting was based on the principles outlined by Meiklejohn et al. (2005, 91-2) where there are three types of refitting bones:

- adjoining broken fragments
- anatomically articulating bones
- side/side antimers which appear identical

These possible refits cannot all provide the same level of security in concluding that they came from a single individual, as a refitted break in the same bone is open to less subjectivity than a comparison of a side/side antimer. Therefore, there have been two levels of certainty applied when conducting refitting of the Havnø remains; high certainty refit and low certainty refit. A high certainty refit is given when adjoining broken bone fragments can be pieced back together. Where bones are anatomically refitted or represent side/side antimers these are considered low certainty refits.

7.3.5.1 Refitting of adjoining broken fragments and side/side antimers

There are a number of cases at Havnø where it was possible to conduct high certainty refits along broken edges of bone (Table 20).

Skeletal element	Specimens refitted	Refitting notes
Adult right ulna	NYA and OTD	High certainty refit; they can definitively be regarded as the same individual but were found in diagonally adjacent squares over 1 m apart.
Adult left ulna	AFH and MSK	High certainty refit of five fragments (recorded under two finds numbers), held in Copenhagen.

Adult right and left ulna	NYA+OTD and AFH+MSK	Low certainty refit of a possible side/side antimer adult right ulna (NYA and OTD) and adult left ulna (MSK and AFH).
Adult metatarsal	OHA and OHL-3	High certainty refit; they were found in adjacent squares, c. 1m apart.
Adult right fibula	LBC-1 and LDU-a	High certainty refit; they were found within the same square-meter grid-square as each other.
Adult left fibula	NSV and QEK	High certainty refit of two specimens.
Adult left and right fibula	NSV+QEK and LBC-1+LDU-a	Low certainty refit of a possible side/side antimer adult right fibula (LBC-1 and LDU-a) and adult left fibula (NSV and QEK).

Table 20: Refitting of adjoining broken fragments and side/side antimers at Havnø

There were two adult ulnas, both broken, contained within the assemblage. It was possible to reconstruct both ulnas by refitting along breaks in the bone (Figure 84), therefore providing a high certainty refit. There is also the possibility that these two ulnas are from the same individual and therefore represent a low certainty refit of side/side antimers. This could not be categorically demonstrated for the purposes of this research as the left ulna was being held in the Zoological Museum in Copenhagen and the right ulna was located at the University of York. However both displayed pitting and osteophyte formation on the trochlear notch (Figure 85) indicating a comparable pathology.

Figure 84: Two refitted adult ulnas from Havnø. Top: Right ulna showing refitted break across shaft. Bottom: Left ulna showing four refitted breaks along the shaft and distal end

Figure 85: Left and right ulna (respectively) from Havnø both showing similar osteophyte formation in trochlear notch which indicates that they may be side/side antimers

Two adult fibulas have also been subject to refitting analysis (Table 20). It was possible to refit with high certainty two mid-shaft fragments of a right fibula (Figure 86) along a break in the bone. Similarly another adult fibula, although in this case a left fibula, was refitted with high certainty along a break in the proximal 1/3 of the shaft (Figure 87). These two fibula specimens are potential side/side antimers which therefore provide a low certainty refit between these bones.

Figure 86: Adult right fibula from Havnø (LBC-1 and LDU-a) refitted with high certainty along break

Figure 87: Adult left fibula from Havnø (NSV and QEK) refitted with high certainty

7.3.5.2 Refitting analysis on the hands

The hands were subjected to refitting analysis to establish the likelihood that they belong to a single individual (Figure 88), as there are no repeated elements and all appear to exhibit total fusion of epiphyses indicating that they are all from an adult individual.

The right hand is more complete than the left, containing 12 specimens (Figure 88). The 1st ray of the right hand is made up of a proximal phalanx (UBQ-b). Another proximal phalanx (LVO) probably belongs to the 2nd ray, based on its size and shape relative to UBQ-b, but is missing the proximal epiphysis. Low certainty refitting based on anatomical size and articulation suggests that an intermediate phalanx (LBU) and a distal phalanx (JZC) could also be part of the 2nd ray of the right hand, both are complete.

The 3rd ray of the right hand is made up of a complete metacarpal (UBQ-a), a proximal phalanx, (PCE-b), also complete, an intermediate phalanx (UDH), and a distal phalanx (OHU, Figure 88). The articulations between these specimens can only be seen as low certainty refitting but nonetheless they are all possibly from the same individual.

The 4th ray is possibly represented by a proximal phalanx (LMW) which is missing part of the proximal epiphysis, a complete intermediate phalanx (LJU) and an almost complete distal phalanx (LVS) with only the distal tip missing (Figure 88). These are all refitted with low certainty based on anatomical articulations. Finally, the 5th ray of the right hand could be represented by a complete proximal phalanx (MBE) which based on relative size when compared to the other phalanges discussed above seems to belong to the 5th ray.

The left hand is made up of three specimens: a proximal phalanx (MDX) which is possibly from the 4th ray, based on size comparisons with the right hand; a proximal half of a left 2nd metacarpal, (NSW); and an almost complete left hamate (RGB, Figure 88).

Although these refits are classed as low certainty, it shows that it is possible for all the hand bones present in the Havnø assemblage to belong to the same individual. This has important implications for the interpretation of the processes which led to the human remains being incorporated into the midden.

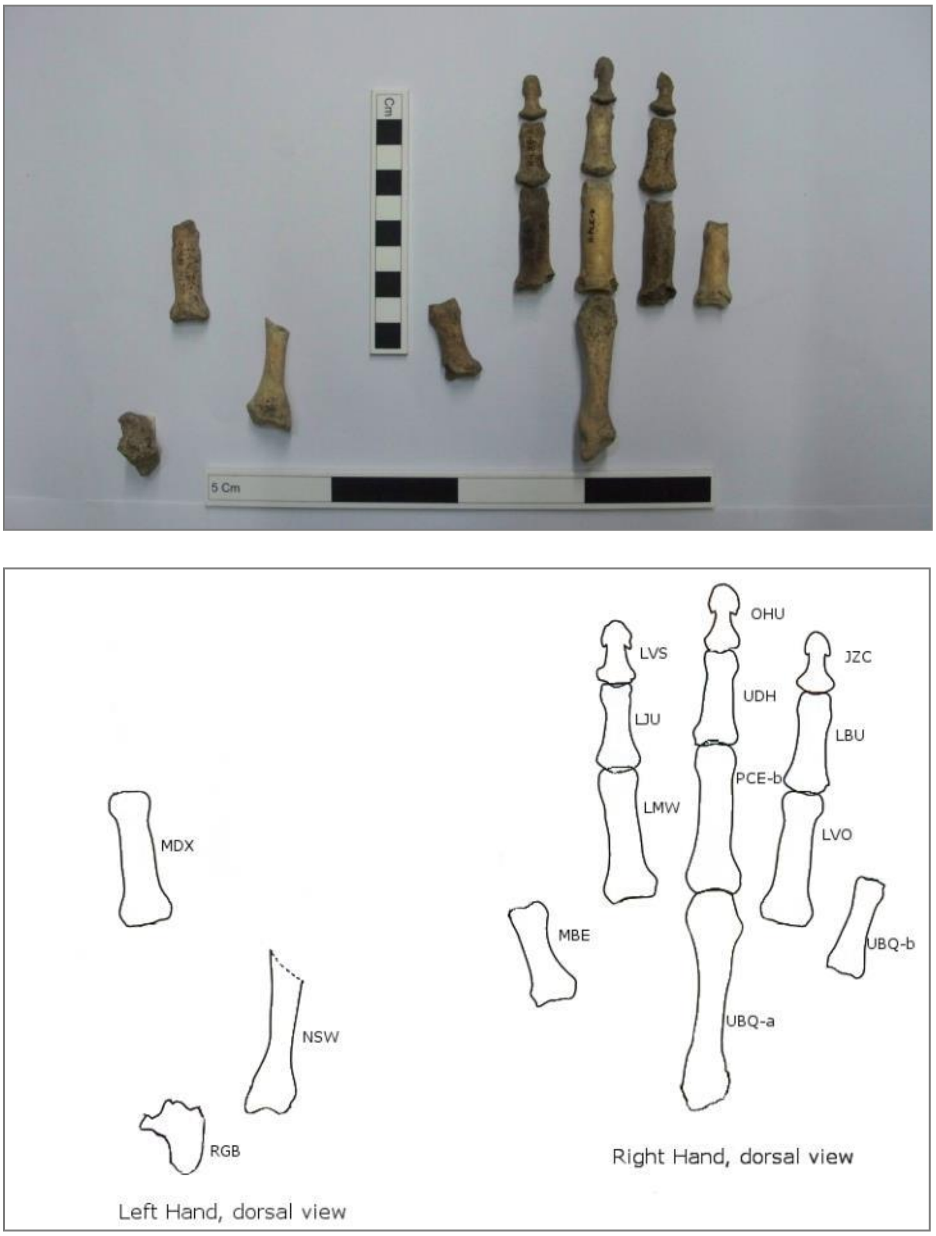


Figure 88: Hand bones, arranged according to refitting, with diagram indicating bone labels. Both hands in dorsal view

7.3.5.3 Refitting analysis of the feet

As with the hands, the feet do not have repeated elements meaning that all specimens could be from the same individual. All are adult remains, and the possibility that they represent more than one individual, due to the presence of DJD in some specimens, has been discounted, due to the known disparity in DJD patterning in the skeleton (Roberts 2009, 174).

The right foot is made up of 6 specimens and the left 3 specimens (Figure 89). A further six specimens (phalanges) are not possible to side securely but have been included in Figure 89 although the siding should not be relied upon. A right navicular bone (MCN) which is almost complete, except for part of the distal articulation which is missing, can be refitted with a complete right lateral (3rd) cuneiform (RNG) based on low certainty anatomical articulation. This cuneiform then also articulates at the distal end with a right 3rd metatarsal (JSU) which is missing part of the proximal and distal epiphyses but is otherwise complete. The proximal phalanx (LAJ) is thought to articulate (as a low certainty refit) with the 3rd metatarsal (JSU). Other bones in the right foot are a complete right 1st metatarsal (THE) (Figure 90), and articulating 1st proximal phalanx (UDE) which is also complete. Again, the refitting is low certainty based on anatomical articulation.

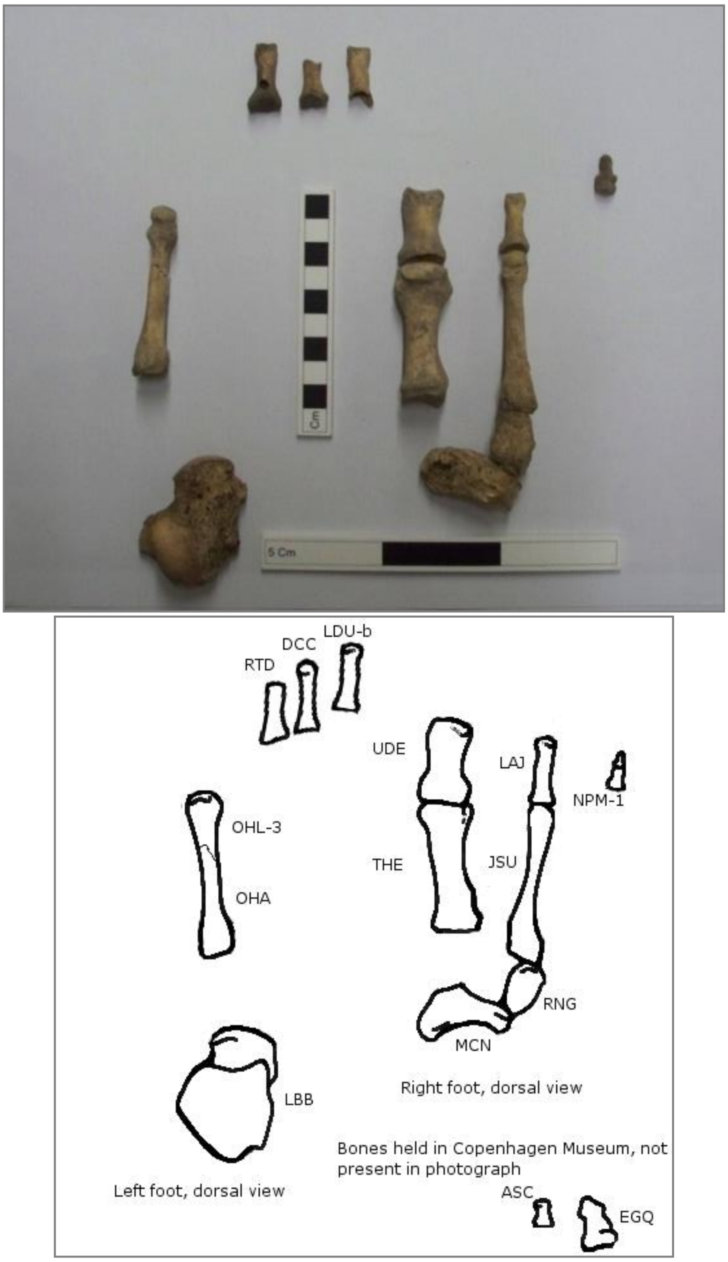


Figure 89: Feet bones arranged according to refitting, with diagram indicating bone labels. Both feet in dorsal view. Diagram also shows ASC and EGQ which are not shown in the photograph as they are held in the Copenhagen Zoological Museum collection

Figure 90: Adult right 1st metatarsal, THE, from Havnø showing osteophyte formation and porosity indicative of DJD

Three specimens are securely identified as belonging to the left foot. These are a left talus bone, (LBB) which is missing part of the head and calcaneal articular surface, and a complete left 2nd metatarsal made up of two refitted parts of the same specimen (OHA and OHL-3). The refit of the 2nd metatarsal is high certainty along a break in the distal 1/3 of the shaft (Figure 89). The metatarsal and the talus (LBB) cannot be securely identified as the same individual but it is possible that they are.

7.4 Spatial distribution of bones

It has been possible to plot the two-dimensional spatial distribution of the Havnø human remains using Arc GIS software (Figure 79). The spatial distribution of the human bone specimens at the site reveals several distinct patterns in the assemblage. The most obvious of these patterns is the collection of a large proportion of the assemblage in the central southern area of the midden, clustered in an area around $12m^2$, and designated here as the major bone group (Figure 91). There are then two specimens in the central part of the midden, designated minor bone group 1, with a further 3 towards the northern extent of the mound in minor bone group 2 (Figure 91). There are two outlying human bone specimens; a tooth and an adolescent radius (Figure 91).

The bone groupings suggest that there is some patterning in the placement of human remains at the site, with a large area to the west of the excavated area which has no identified human remains at all. First impressions of this spatial patterning imply that there are distinct processes affecting the human remains which have deposited them in this way in the midden. However, it is also possible that there was a primary burial in the vicinity of the major bone group which has then been disturbed causing the human remains to be distributed further north across the midden. This possibility was assessed through more detailed analysis of the human remains.

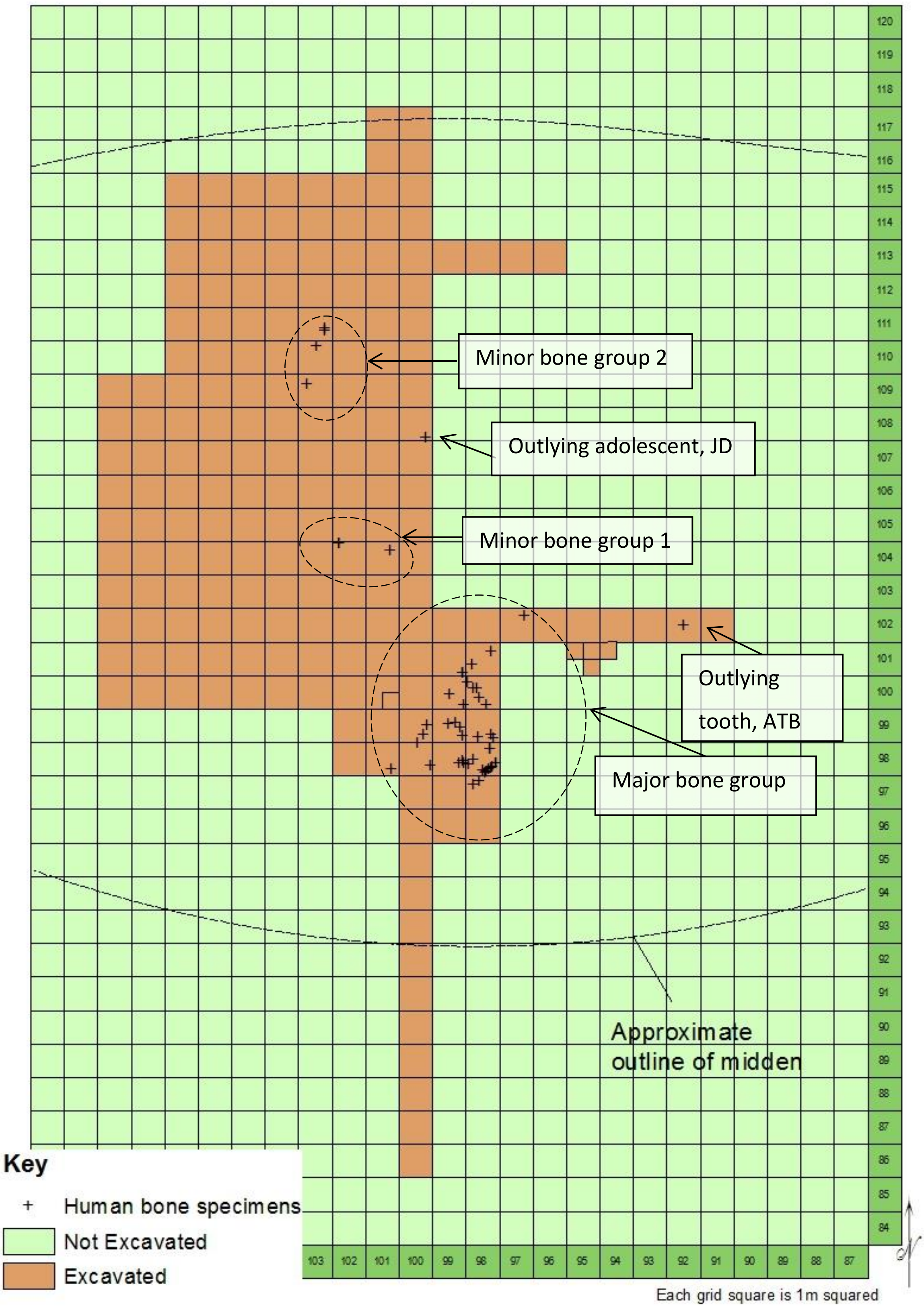


Figure 91: Plot showing the spatial location of the bone groups at Havnø

7.5 ZooMS

7.5.1 Identifying missing skeletal elements

Initial observations of the skeletal assemblage from Havnø indicated that there was a large area of the midden in the west of the excavated area seemingly devoid of human remains (Figure 91) and that there was a noticeable absence of vertebrae and ribs (Figure 92). Given the fragmentary nature of the bone specimens, the missing ribs and vertebrae might be the result of identification bias as it can be hard to securely identify fragmentary bone specimens, particularly ribs, as definitively human, and therefore some of the remains might have been omitted from the assemblage.

In order to test whether this missing bones were due to identification bias or the result of a taphonomic process, a new bioarchaeological analysis, ZooMS (Zooarchaeology by Mass Spectrometry), pioneered at The University of York (Buckley et al. 2009; Buckley et al. 2010; Collins et al. 2010), was conducted on a representative sample of the Havnø unidentified bone assemblage.

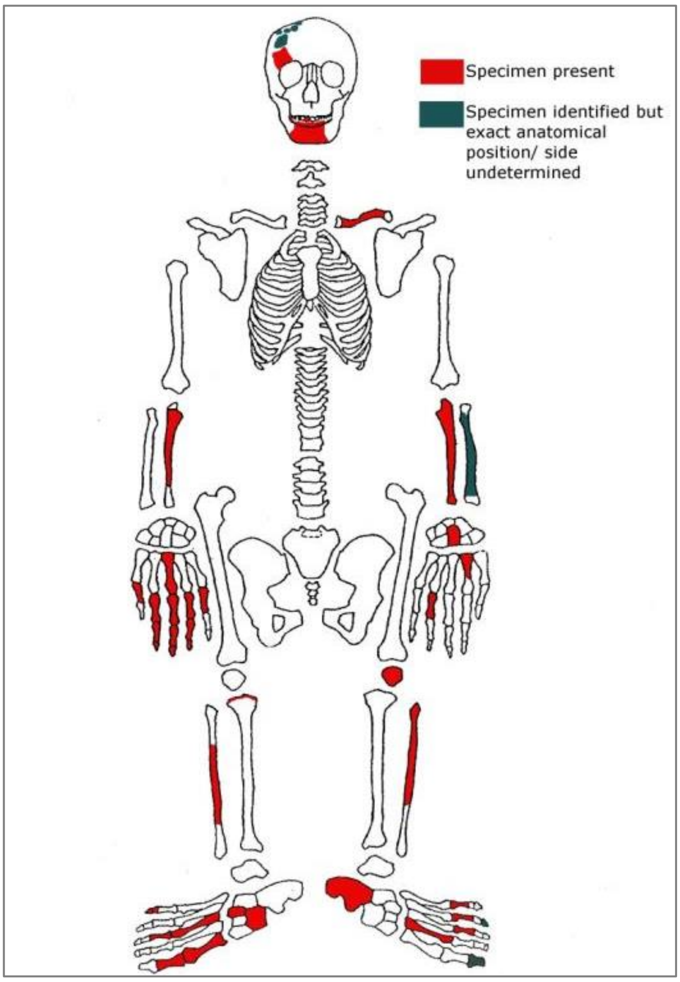


Figure 92: Skeletal element diagram showing entire human bone assemblage from Havnø. Note the complete absence of ribs and vertebrae

Potential samples were collected during fieldwork on site in August 2011 and during a research trip to Copenhagen Zoological Museum in February 2012. The samples collected during fieldwork were more random in nature with a variety of small fragments taken from areas of the midden where human remains were known to have been found. The samples acquired from the Zoological Museum were more selectively collected fragments that looked like vertebral and rib specimens. A total of 89 samples were collected for ZooMS analysis from across the midden not just in the areas where human remains were found providing a small but representative sample of unidentified bones for analysis (Figure 93).

7.5.2 Results

Lab work and preparation of the spectra was completed by colleagues within the Bioarchaeology Department at the University of York. The spectra produced by the Havnø samples were viable for analysis. The primary intent was to identify potential human remains within the unidentified samples and therefore it was decided to conduct identification using the peptide marker list, focussing on the expected peaks for humans (and primates). Primarily the peak 1477.7 m/z was used, and then any samples that showed this peak were checked for other human markers.

Only one specimen (FLV) from the 89 samples tested showed the human marker 1477.7 m/z. This potential human specimen was then analysed for additional human markers (Table 21) which were present (see Appendix for full results). FLV could not be securely attributed to a specific skeletal element and it can only be considered an unidentified human bone.

Bar	Peak (m/z)	Present?
A	None	-
B	1477.7	Yes
C	1580	Yes
D	2115	Yes
E	None	-
F	None	-
G	2957	Yes

Table 21: Summary of the markers present in the Havnø human specimen, FLV, identified through ZooMS analysis

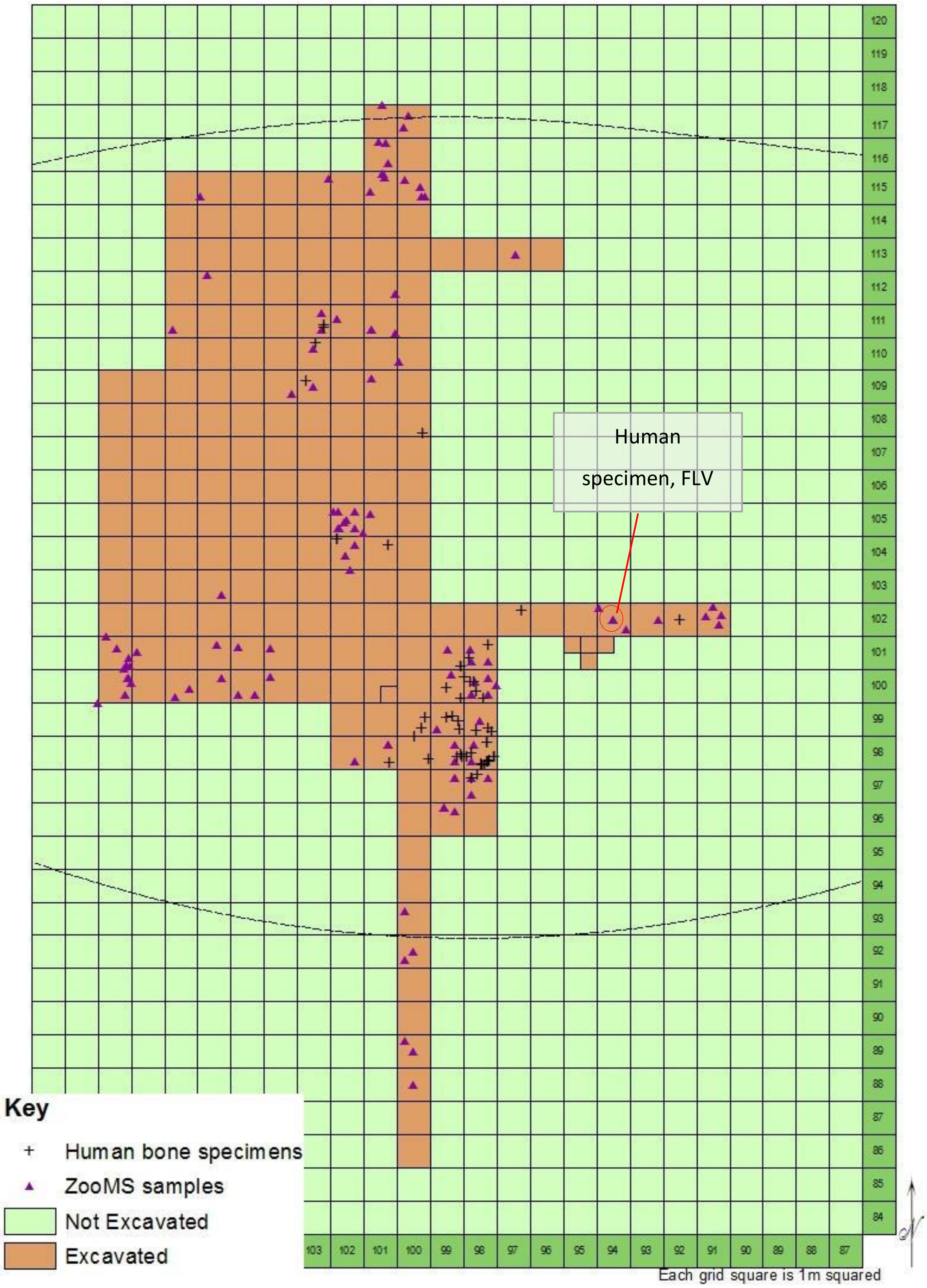


Figure 93: Spatial distribution of samples collected for ZooMS analysis at Havnø and the location of excavated human remains specimens.

The spatial location of the human specimen (FLV, see Figure 93) is interesting as it comes from an area to the east of the midden where only one other human bone specimen has been found. The amount of excavation that has occurred in this area is limited to a single metre wide extension of the main trench meaning that there is potential of finding more human remains in this area.

7.5.3 Implications of ZooMS analysis

Although a sample of 89 specimens was selected for ZooMS analysis this is only a small proportion of the unidentifiable fragments of bone resulting from the excavation. However, the intention was not to provide a statistically significant sample but to use this new technique to identify the potential loss of osteological information in unidentified specimens.

These results show that within small unidentified fragments of bone the amount of human remains that are lost is potentially likely to be small. However, the presence of a human specimen in an area of the midden which had only been excavated with a narrow spit trench and in which only one other human specimen had otherwise been found highlights the potential that further human remains may lie in this area of the midden.

Additionally the ZooMS results do add to the understanding of the placement of human remains at the site because the sampling strategy specifically targeted bones which were morphologically consistent with ribs and vertebrae, the missing skeletal elements from the human assemblage, but none of these were identified by ZooMS as human. The one bone identified as human using the ZooMS technique, could not be securely attributed to skeletal element. The apparent absence of ribs and vertebrae from the Havnø assemblage could therefore be real and might be the result of placement practices enacted on the human remains rather than non-human taphonomic processes of fragmentation and disturbance.

The ZooMS analysis also supports the observation that there is an area to the west of the midden which has not yielded human remains, as it also failed to identify any human specimens in this area. It could imply that this area really does not contain human remains making their groupings in other areas of the midden more significant. It also lessens the possibility that inhumation burials at the site have been disturbed and distributed widely across the midden as fragmentary remains.

7.6 Dietary isotopes

Studies on dietary isotopes carbon 13 (δ13C) and nitrogen 15 (δ15N) have become commonplace in prehistoric research, particularly in discussions on the Mesolithic-Neolithic transition. There has been strong debate about the speed and severity of the shift from heavily marine diets in the Mesolithic to heavily terrestrial diets in the Neolithic (for debate see Milner et al. 2006; Milner et al. 2004; Richards and Schulting 2006; Richards and Hedges 1999a; Schulting and Richards 2002).

7.6.1 Isotope sampling strategy at Havnø

During discussions with colleagues about which samples from Havnø would be suitable for dietary isotope analysis (for the PhD thesis by Harry Robson, University of York), it became clear that stable isotope values are used within dietary studies to determine the presence of different individuals where the isotope values are seen to vary significantly. Therefore, if it is possible to determine individuals from differing isotope results this could have an impact on the MNI of fragmentary remains within a shell midden context.

On further investigation no specific studies on the variation of human isotopes within a single body were found although one does consider the variation within individual mink and rabbits (DeNiro and Schoeniger 1983). This study showed that the difference in δ13C values between bones of the same individual mink and rabbits differed by less than 1 part per mil (DeNiro and Schoeniger 1983, 202). Due to the limited focus on the identification of individuals in the isotopic literature this study is therefore the best proxy available for human remains. Hence, it can be tentatively assumed that any difference in δ13C which is greater than 1 part per mil means that the samples are attributable to a different individual, but any differences lower than this cannot be distinguished as individuals. However, further work on the variation in δ13C values exhibited by human individuals would be needed to make this assumption more robust.

In order to reveal the potential for using isotopes to identify individuals, the sampling strategy for the dietary stable isotope analysis at Havnø was designed with a joint purpose. For the dietary isotope study it was intended to test the maximum number of possible individuals based on the osteology. In order to be able to use stable isotope analysis to refine the MNI at the site, re-fitting of bone specimens was used to select two parts of the same bone (and therefore the same individual) which had been found in different areas of the midden. The re-fitted bone would then provide a control for the variation in δ13C of a single individual within the Havnø midden.

Use of the results from these control samples would allow a greater degree of certainty to be obtained when assessing the dietary variation between the known individuals as well as amongst the other remains in order to assess whether these are the same individual. At the time of isotope sampling only the osteological MNI of 3 was known; one adult, one juvenile and one adolescent but it was only possible to sample the adult and the juvenile because the adolescent radius bone JD was located in Copenhagen Zoological Museum and not available for sampling.

The sampling strategy was designed to test as many specimens belonging to distinct individuals as possible whilst at the same time testing some specimens which were known to be from the same individuals (Table 22). In total 17 specimens were tested for dietary isotopes; additional samples, not discussed here, were selected by Harry Robson to form part of his study on the dietary variation at Havnø (full discussion can be found in Robson 2015). The spatial distribution of skeletal remains tested for dietary isotopes (Figure 94) shows that the samples were selected from remains across the midden; in the major bone group and both of the minor bone groups.

Specimen tested	Specimen description	Reason for testing
Adult right ulna	High certainty refit of two specimens, Figure 84 (NYA and OTD)	They can definitively be regarded as the same individual but were found in diagonally adjacent squares over 1 m apart in the major bone group. This means that by conducting isotope analysis on both specimens any variation in the isotope signature based on their deposition could be considered.
Adult metatarsal	High certainty refit of two specimens, Figure 84 (OHA and OHL-3)	They were found in adjacent squares, c. 1m apart in the major bone group. Tested as a control sample to show variation in a known individual.
Adult right fibula	High certainty refit of two specimens, Figure 86 (LBC-1 and LDU-a)	They were found within the same square-meter grid-square as each other, in the major bone group, hence providing less potential for control purposes but they are securely identified as one individual.
Adult left fibula	High certainty refit of two specimens, Figure 87 (NSV and QEK)	A possible side/side antimer with LBC-1 and LDU-a. There is a possibility that these four specimens may represent one or two individuals, especially given the fact that NSV/QEK are found several metres away from LBC-1/LDU-a. Isotope testing of all four specimens could determine whether one or two individuals are represented based on the refitted broken fragments providing a control for the more speculative side/side antimers.
Adult patella	One specimen (ABFU)	Found in minor bone group 1. The location of this specimen means it might be a different individual.
Phalanx and metatarsal	Two specimens, Figure 89 (UDE and THE)	Both show signs of DJD, these two specimens were sampled in order to establish whether they have an isotope signature outside of the range expected for one individual in order to test whether the presence of DJD indicates an third individual of older age at the site.

Specimen tested	Specimen description	Reason for testing
Adult 3rd metacarpal and adult proximal phalanx	Two specimens, Figure 88 (UBQ-a and UBQ-b)	Both found in the same position in the midden (hence both being labelled UBQ, the “a” and “b” suffixes are additions for this study only) but they do not belong to the same digit making it impossible to say whether they are part of the same individual by refitting.
All juvenile calvaria	Four specimens (LDY-2, VNV, XYB and QQB)	Samples from each of the four fragments of juvenile calvaria located in minor bone group 2, and one in the major bone group (LDY-2). Sampled in order to test the difference in isotopic signature between this juvenile individual and the adult remains.

Table 22: Specimens chosen for dietary isotope sampling at Havnø

7.6.2 Refining minimum number of individuals using dietary isotopes

The results of the dietary isotope analysis (Figure 95) show that there is a variation in dietary signatures within the Havnø site. Detailed discussion of the dietary implications of these results is part of another research project (Robson 2015) but there is clear evidence of both distinctly marine and distinctly terrestrial diets at the site.

In terms of refining the MNI at the site the results are very persuasive. The refitted parts of single individual specimens show variation in $\delta 13C$ readings of less than 1‰ (Table 23) in line with the variation expected by DeNiro and Scheoniger (1983). Knowing that variation within an individual is likely to be less than 1‰ it can be assumed that differences between isotope values above this threshold at Havnø are probably distinct individuals, even if their diet is within the same overall range. However caution must be exercised in interpreting the specimens with differences less than 1‰ as a single individual because it is not known whether two individuals eating the same diet would also fall within this range. So the differences between isotope signatures still only provides a minimum number of individuals, recognising that there could always be more individuals than the number stated.

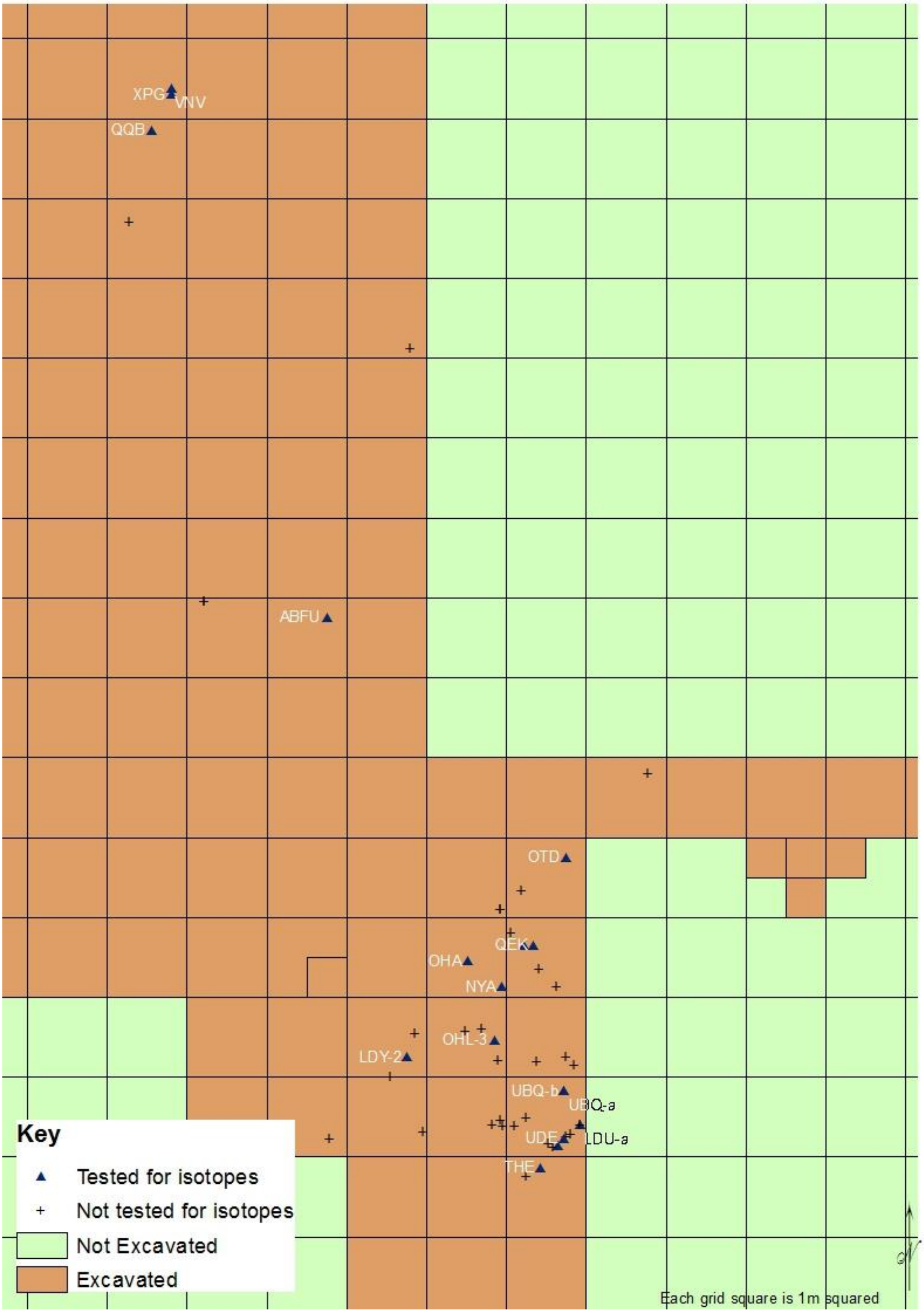


Figure 94: Plan showing the location of samples tested for dietary isotope analysis at Havnø

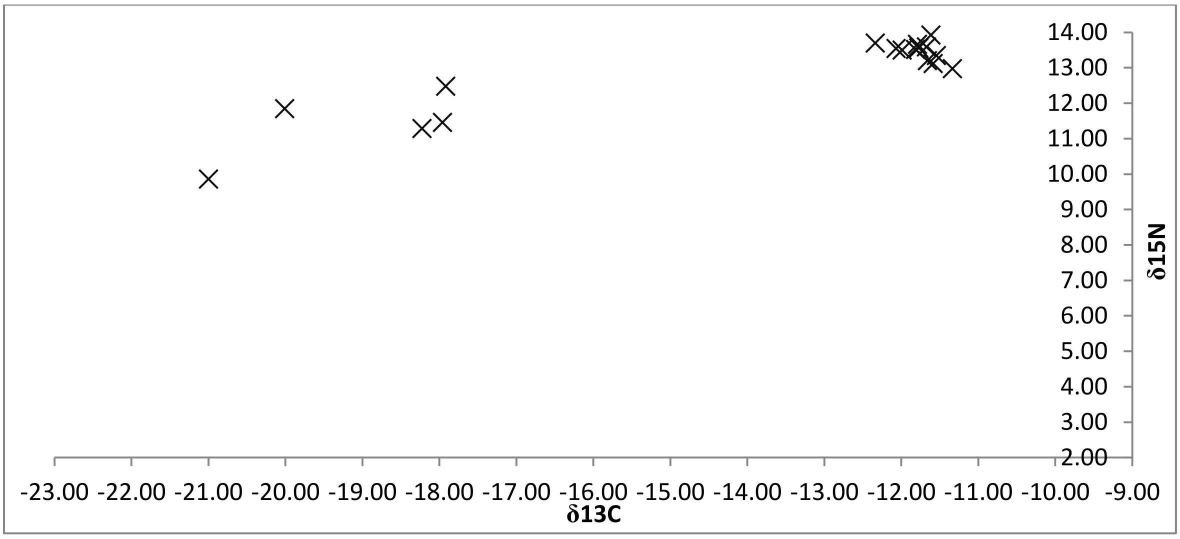


Figure 95: Results of dietary isotope testing on human remains at Havnø, showing the presence of both terrestrial and marine diets at the site

The low certainty refitted side/side antimers of the left and right fibula have δ13C values with less than 1‰ difference (Table 23). This adds weight to the likelihood that they are from the same individual but it cannot be concluded for certain. Similarly, the two specimens showing evidence of DJD, the phalanx and metatarsal, which might have been from a distinct individual, are not more than 1‰ different from the other specimens tested (Table 23) which means that they cannot be presumed to be a distinct individual.

The MNI from osteoarchaeological analysis alone was deemed to be three; one adult, one adolescent and one juvenile. The results of isotope analysis at Havnø indicates that the MNI can be refined to five individuals; two adults, two juveniles and one adolescent.

The adult remains identified by osteoarchaeology can be split into two distinct adults based on the isotope results. Adult one is represented by twelve adult specimens from a variety of limb and extremities, all of which fall within the marine dietary range (Figure 96). These specimens show a variation of 1.01‰, indicating that they could all belong to a single individual or several individuals sharing the same diet. This group of adult remains forms a large part of the major bone group in the midden (Figure 97). Their close spatial grouping, consistent isotopic signature and adult ageing implies that this group of bones is highly likely to be from a single adult individual.

Refitted bones	Reason for testing	Isotope Results	
		Specimen	δ13C ‰
Adult right ulna, NYA and OTD	High certainty refit of two specimens	NYA	-11.79
		OTD	-11.54
		Difference in ‰	0.25 (< 1‰)
Adult right fibula, LBC-1 and LDU-a	High certainty refit of two specimens	LBC-1	-12.34
		LDU-a	-11.81
		Difference in ‰	0.53 (< 1‰)
Adult left fibula, NSV and QEK	High certainty refit of two specimens	NSV	-11.99
		QEK	-11.67
		Difference in ‰ between NSV and QEK	0.32 (< 1‰)
Adult right and left fibula	possible side/side antimers	Greatest difference in ‰ between left and right fibula	0.67 (< 1‰)
Adult right 1st metatarsal and phalanx, UDE and THE	Low certainty refit of anatomical articulation and both showing DJD	UDE	-11.33
		THE	-11.77
		Difference in ‰	0.44 (< 1‰)
Adult left 2nd metatarsal, OHA and OHL-3	High certainty refit of two specimens	OHA	-11.66
		OHL-3	-11.58
		Difference in ‰	0.08(< 1‰)
Adult 3rd metacarpal and adult proximal phalanx, UBQ-a and UBQ-b	No demonstrated refit but found close together	UBQ-a	-12.07
		UBQ-b	-11.61
		Difference in ‰	0.46 (< 1‰)

Table 23: Variation in stable isotope results testing for individual variation at Havnø

The second adult is identified with a terrestrial dietary signature of -21‰ (on patella ABFU, Figure 96). This specimen was located in the centre of the midden isolated from other human specimens except from the adult partial mandible and teeth (YNW-a, Figure 97).

There was a single juvenile identified by osteological analysis which can be separated into at least two individuals based on the dietary isotope results. The first juvenile is identified by a cranial fragment (LDY-2) found in the proximity of the major bone group of adult remains (Figure 97) and showing a terrestrial δ13C value of -20.01‰.

The second juvenile is represented by cranial fragments with terrestrial δ13C signatures ranging from -17.91‰ to -18.22‰ (a difference of 0.31‰), implying that they are from either one individual or individuals with a similar diet. These juvenile cranial fragments were located in the northern area of the midden, away from the major bone group (Figure 97).

The isotope signature of juvenile one, -20.01‰, is distinct from the juvenile two remains which are around -18‰ meaning that they are very likely to be different individuals. It is also quite distinct from the adult patella (ABFU) which had a δ13C value of -21.00‰, nearly 1‰ difference. Both the location of juvenile 2 within the main bone group and the dietary signature distinct from juvenile 1 means that it is very likely to belong to a distinct individual.

The application of dietary isotope analysis on the human remains from Havnø to distinguishing individuals demonstrates that a carefully designed sampling strategy can help to refine the MNI at a site and give a clearer picture of the number of people buried at the site.

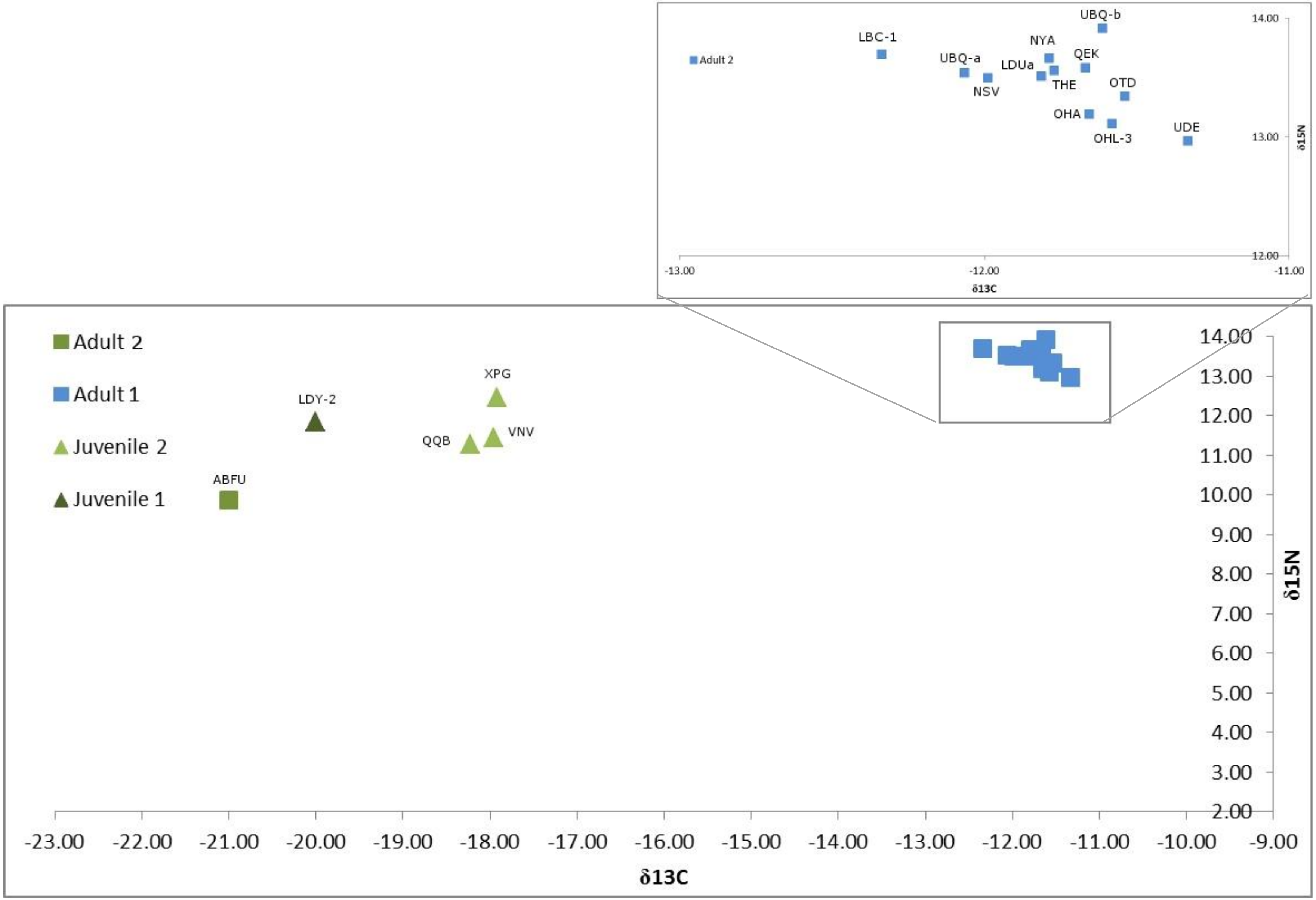


Figure 96: Plot showing the dietary isotope data according to individuals for human remains at Havnø. Green are terrestrial diets and blue are marine

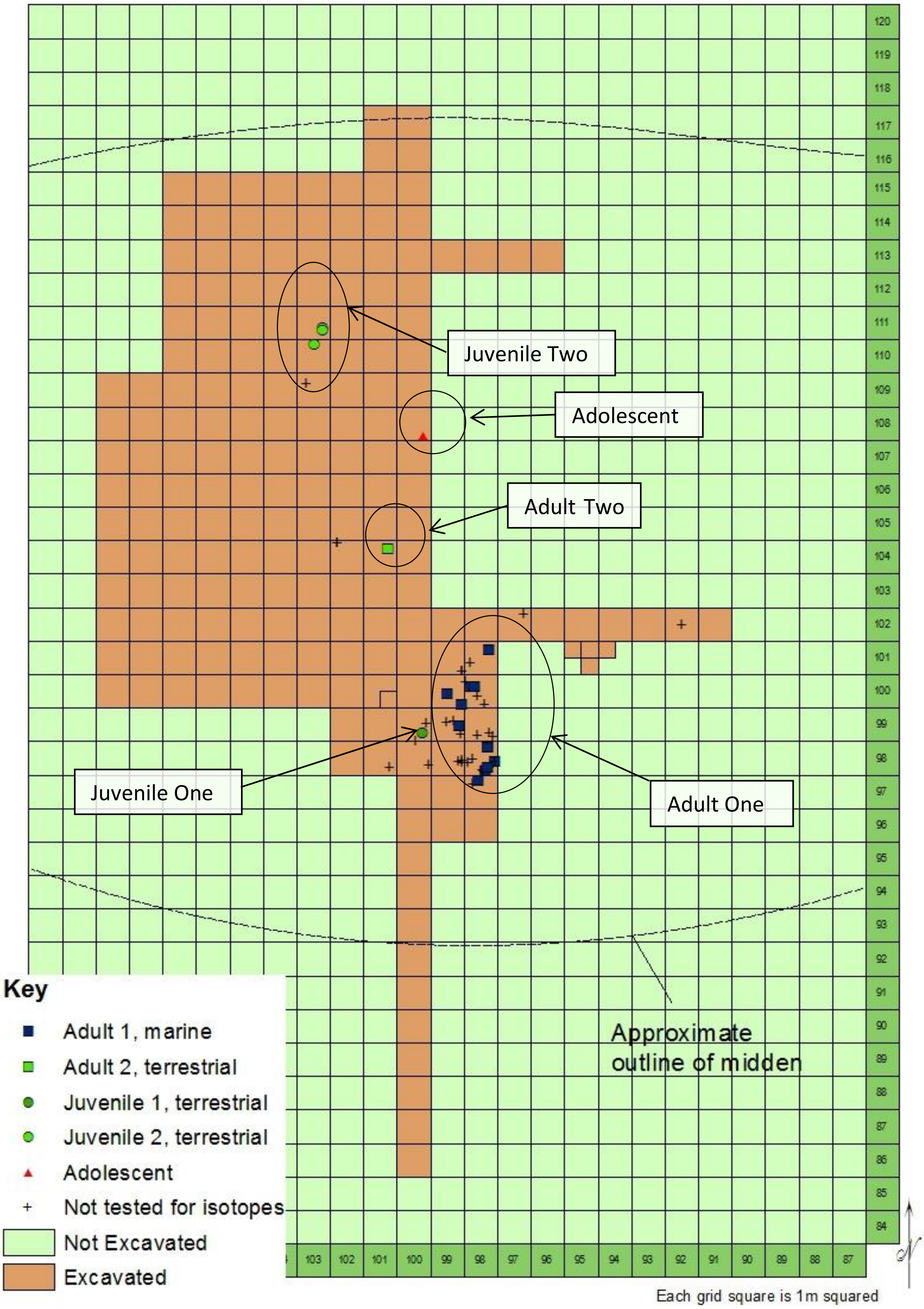


Figure 97: Plot showing the spatial distribution of individuals identified using dietary isotope analysis at Havnø. Note the adolescent was not tested for isotopes but is a distinct individual based on the ageing of the remains

7.7 Dates

Radiocarbon dating has been carried out on five human bone samples for the purposes of this study. These specimens were chosen from across the midden; in the major bone group and both minor groups, and from both adult and juvenile remains. Calibration has been carried out using Oxcal 4.2 (Bronk Ramsey and Lee 2013) and the calibration curves have been applied based on discussion with Gordon Cook, SUERC (Cook 2012, pers. comm.). Three samples (two pieces of juvenile crania and an adult patella) contained δ13C levels equivalent to a terrestrial diet and therefore these have been calibrated with no marine correction. Contrastingly, two samples (adult ulna and adult metatarsal) have δ13C values equivalent to an almost entirely marine diet, although their δ15N values suggest that the diet was not purely marine as they are not as extreme as the δ13C values. In order to provide the most accurate calibration of these samples more needs to be known about what types of fish and shell fish were being eaten and the environment that they lived in. This is not possible for the purposes of this study and therefore a 100% marine correction has been applied to the two samples in question. A ΔR correction value has been applied based on the marine correction database (Stuiver et al. 2014).

The dates show that the midden was in use for burial in two or three phases (Table 24 and Figure 98). The first occurred just before the transition to agriculture around 4,000cal BC when adult one (ulna OTD and metatarsal OHA) which had a marine based diet, was incorporated into the midden around 4,600- 3,700cal BC. Juvenile one (cranial fragment LDY-2), which is located in the same area of the midden as the main bone group (Figure 99) but has a contrasting terrestrial dietary signature, might have been deposited around the same time, or slightly later than adult one, possibly after the transition to the Neolithic around 3954 – 3795cal BC. Finally, another phase of deposition occurred when adult two (patella ABFU) and juvenile two (cranial fragment XYB), both with terrestrial diets, were incorporated into the midden between 2512 – 2908cal BC.

The radiocarbon dating supports the refinement of the MNI to 5 which was suggested by the isotope analysis. The two dated juvenile cranial fragments date to over 1,000 years apart, strongly suggesting that there are two juveniles represented in the assemblage. Additionally the dated adult remains show similarly distinct differences in date with the patella (ABFU) being dated to as much as 1500 years later than the other two adult specimens the ulna (OTD) and metatarsal (OHA).

This sheds new light on the possible use of the midden as a burial place, as it was used at least two or three times over around 1500 years, making it likely that the burial practices employed at the site were distinct and did not necessarily involve the same treatment of the body.

Lab Code	Bone number	Species	Skeletal element	Age	C14_d13C	C14_d15N	C14_C/N ratio	Radiocarbon age BP	Radiocarbon error	New calibrated dates
SUERC-42621 (GU25953)	ABFU	*Homo sapiens*	Patella	Adult	-21.00	9.40	3.2	4101	29	2862 – 2512 cal BC
SUERC-42620 (GU25952)	LDY-2	*Homo sapiens*	Cranial fragment	Juvenile	-20.10	11.70	3.2	5067	29	3954 – 3795 cal BC
SUERC-42625 (GU25954)	XYB	*Homo sapiens*	Cranium	Juvenile	-18.30	11.60	3.2	4233	29	2908 – 2721 cal BC
SUERC-42627 (GU25956)	OHA	*Homo sapiens*	Metatarsal	Adult	-11.40	13.20	3.2	5869	29	4630 – 3716 cal BC
SUERC-42626 (GU25955)	OTD	*Homo sapiens*	Ulna	Adult	-11.60	13.00	3.1	5880	29	4651 – 3736 cal BC

Table 24: Radiocarbon dating of human bones at Havnø. Calibrations used Oxcal 4.2 (Bronk Ramsey and Lee 2013). Three dates have been calibrated using the IntCal13 terrestrial curve and two with the marine curve Marine 13 (Reimer et al. 2013) with a ΔR correction of 134 +/- 204 calculated using the marine correction database (Stuiver et al. 2014).

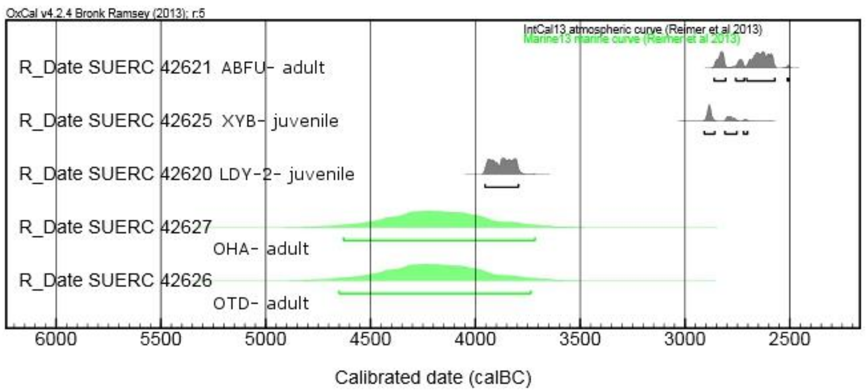


Figure 98: Plot of radiocarbon dates on human bone at Havnø, using Oxcal 4.2 (Bronk Ramsey and Lee 2013). Three dates have been calibrated using the IntCal13 terrestrial curve and two with the marine curve Marine 13 (Reimer et al. 2013) with a ΔR correction of 134 +/- 204 calculated using the marine correction database (Stuiver et al. 2014).

The refinement of the MNI using the radiocarbon dates on only 5 out of 51 specimens illustrates how the understanding of burials in shell middens could be greatly augmented by the widescale testing of fragmentary human remains for isotopes and radiocarbon dates. It is not safe to assume that all disarticulated human remains within a midden are from the same timeframe and only by dating a significant proportion of the total assemblage will it be possible to draw confident conclusions about when the human remains were placed into the midden.

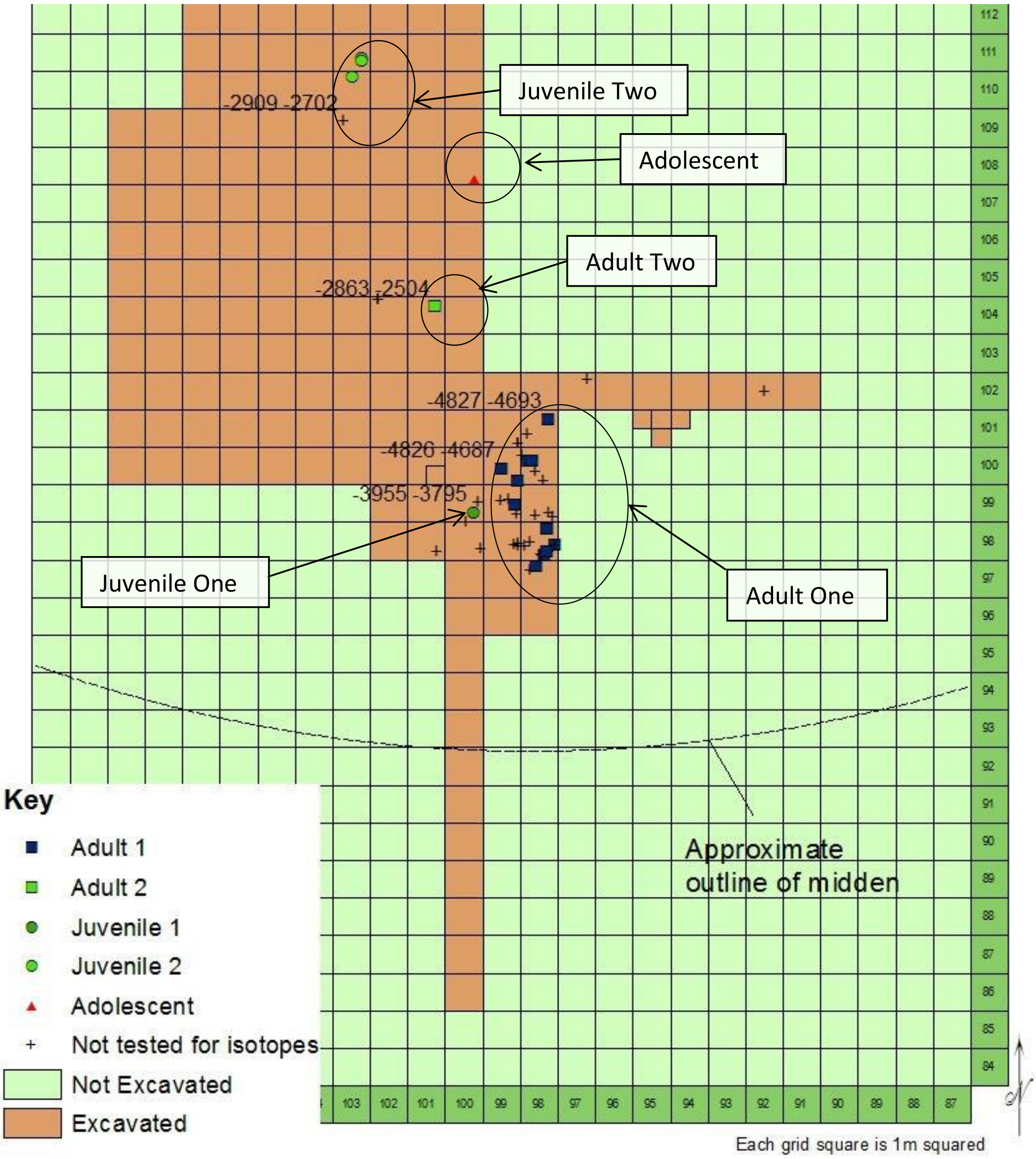


Figure 99: Spatial location of human remains at Havnø showing the diet, individuals and radiocarbon dates

7.8 Skeletal element analysis

The possible spatial patterning of the human remains at the site into the major bone group and two minor bone groups (Figure 91) indicated that there might be distinct depositional events placing the separate groups of remains into the midden. This possibility has been strengthened by the identification of distinct individuals in each of the bone groups using dietary isotope analysis and radiocarbon dating (Figure 99). Not only do the groups contain individuals with distinct dietary signatures but they are likely to be from very separate temporal phases of use of the midden as a burial place. It has therefore been established that the 50 human bone specimens represent a MNI of five individuals contained in the Havnø shell midden (Figure 100).

7.8.1 Skeletal elements present

It appears that the only mixing of individuals within the midden occurred with the inclusion of a single juvenile cranial fragment into the main bone group containing adult one. Further investigation to the south-west of the excavated area might reveal more remains belonging to this juvenile individual (Figure 99). It is not possible at this stage to attribute the outlying bones, an adolescent radius, the tooth and the unidentified skeletal specimen from ZooMS analysis, to individuals at this stage. Further analysis of dietary isotopes and/or radiocarbon dating is recommended on these bones to establish how they fit in to the pattern described here.

The non-adult human remains are represented by single skeletal elements; the juveniles are both represented by only cranial fragments and the adolescent by a radius (Figure 101). Adult two is also represented by a single element, a patella, although it is possible that the adult mandible which is located with it in minor bone group 1 may also be from the same individual. It is also possible that there are further parts of each of these individuals contained in unexcavated areas of the midden and the location of these remains, particularly the adolescent radius, implies that there may be more bone to be found in adjacent unexcavated areas (see Figure 99). The non-adult individuals at Havnø are spatially distributed in a separate area of the midden, with the exception of one specimen, a juvenile cranial fragment (LDY-2), indicating that they are distinct from the adult remains not only in age but possibly represent individual depositional episodes.

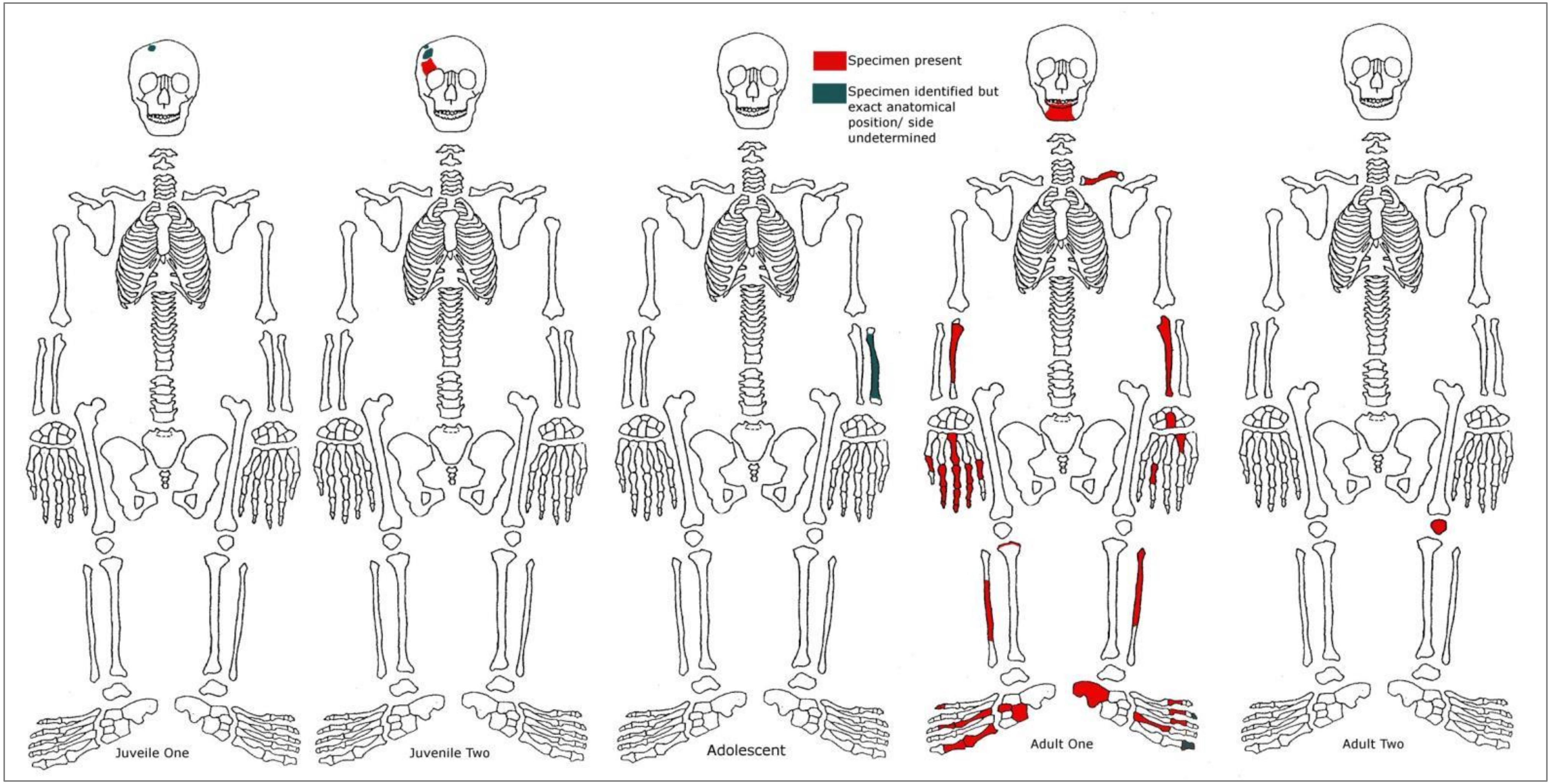


Figure 100: Skeletal element profile of 5 individuals at Havnø

The bones belonging to adult one come from several parts of the body which contrasts with all the other individuals at the site (Figure 101). There is a notable absence of bones from the ribs and spinal column in the adult assemblage with the majority of the remains coming from the distal limb bones and extremities. In fact 30 of the skeletal specimens belonging to adult one in the major bone group assemblage come from the hands (15) and feet (15).

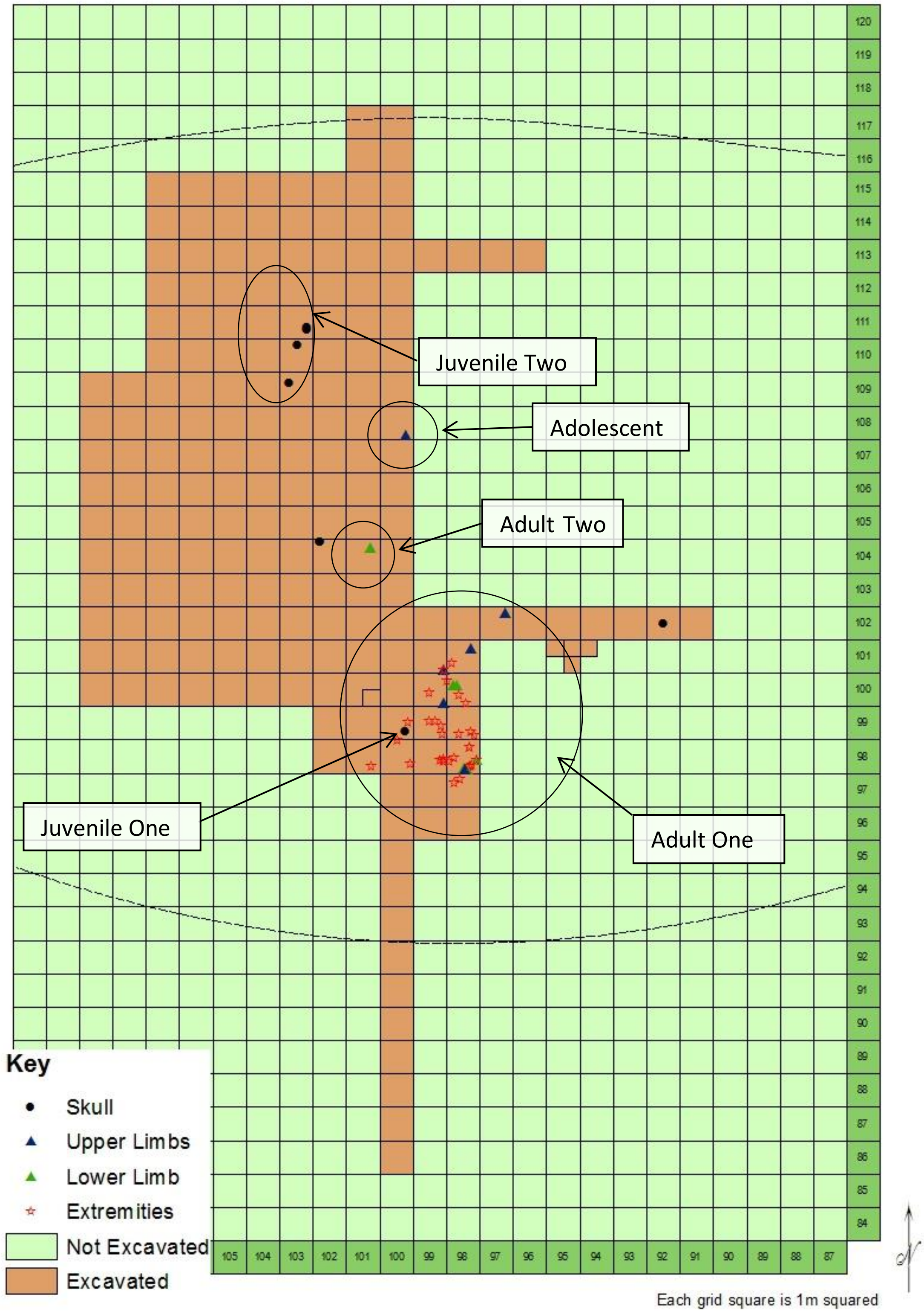


Figure 101: Plot of the position of the human remains according to body part from Havnø

7.8.2 Comparison of skeletal element profiles

The very fragmentary nature of the juvenile, adolescent and adult two's assemblages at Havnø are difficult to compare to any of the potential skeletal profiles presented in Chapter 3. It is possible that more of these individuals are located in the unexcavated areas of the midden, which only further excavation can resolve. It is also possible that these remains were brought to the midden as single skeletal elements which were part of secondary funerary processes akin to the type of processing of the body and ancestor worship which is commonly accepted in Neolithic studies (Parker-Pearson 1999; Parker-Pearson 2000; Whitley 2002).

The main bone group consisting of adult one's remains do provide the opportunity to compare the potential skeletal profiles which are based on taphonomic models of burials. The skeletal element profile of adult one is most like the remains expected from profile 4, scavenged remains which were removed from the main location of the body by animals, or like profile 6, the residual bone left behind after secondary burial processes (Figure 102). Neither is an exact fit due to the presence of distal limb bones like the ulna and fibula but absence of the proximal limb bones like the humerus and tibia.

Given the presence of distal limb bones it seems like the closest fit is with the scavenged remains removed by animals. It is known that scavenging animals remove the limbs from the main carcass and drag them away to an area of safety where they can consume the meat away from the competition (Binford 1981, 42). However, this behaviour is also highly likely to cause gnaw marks on the bone which is entirely lacking from the bone assemblage at Havnø. The absence of gnaw marks does not prove that scavenging did not take place but it does question whether this is the most plausible explanation.

The other possibility is that the lower parts of the arms and legs, including the hands and feet, were deposited into the midden as part of secondary funerary treatment. If excarnation took place at the site then it is possible that these parts of the body were not collected after skeletonisation had occurred and were instead left behind and incorporated into the midden. Equally, it is possible that skeletonisation of the body occurred elsewhere and the group of limb bones and extremities were intentionally placed into the midden as a secondary act. The close grouping of the remains might suggest that this is a possibility, as would the presence of extremities which are known not to survive well on archaeological sites (Cox and Bell 1999, 945; Henderson 1987; Nawrocki 1995, 62; Waldron 1987) but survive in abundance in the Havnø assemblage.

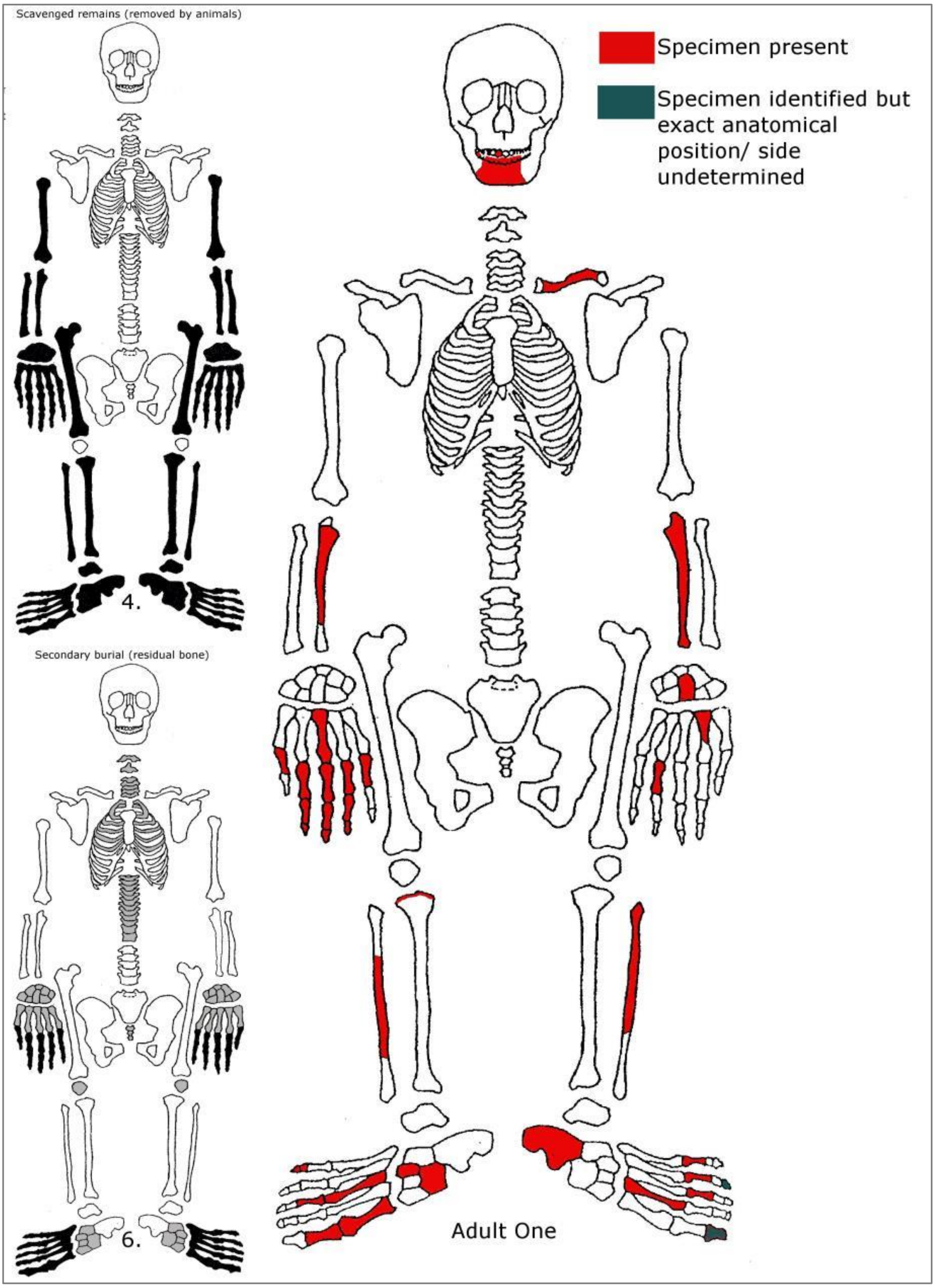


Figure 102: Skeletal element diagram of adult one at Havnø compared with potential skeletal diagrams 4, scavenged remains, and 6, secondary burial

7.8.3 Spatial patterning of adult one's bones

It is possible to look in more detail at the spatial location of adult one's bones to assess whether there is any potential anatomical positioning of the bones, which might shed light on whether the remains were incorporated into the midden as part of animal scavenging or secondary funerary treatment. The upper limb specimens are all located north of the centre of the group and there are two small areas within the group which contain lower limb bones (see Figure 101) whilst the extremities are scattered across the group. This distribution seems to suggest that the two areas of lower limb bones possibly represent the two lower limbs of an individual. When the specific specimens are identified within this group the picture becomes clearer (Figure 103).

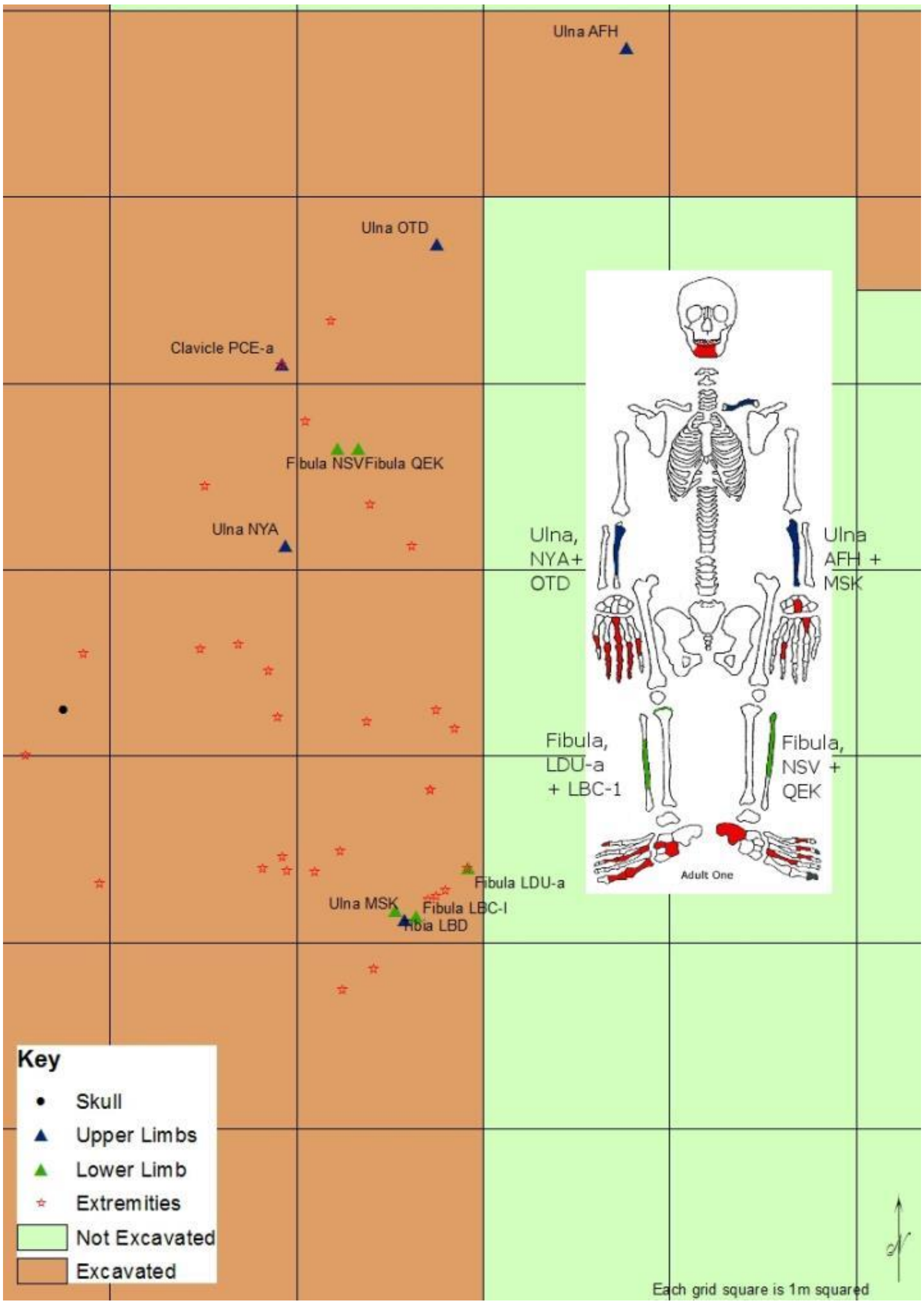


Figure 103: Detail of adult one in the major bone group at Havnø showing distribution of parts of the body and possibility of anatomical positioning

The two specimens belonging to the right fibula (LDU-a and LBC-1), which have been refitted with high certainty, are located in the same quarter of a grid square indicating that they were found less than 25cm^2 apart. Also found in this direct location is the very top of the proximal epiphysis of a right tibia (LBO). The close association between the right tibia and fibula suggests that some anatomical positioning might be present. The left fibula (NSV and QEK) is located 2 metres north of the right fibula, again in close proximity to each other. These have also been refitted with high certainty.

The upper limb bones within the major bone group show less anatomical integrity within the midden than the lower limb bones. For example, the high certainty refitted specimens of the right ulna (OTD and NYA) are separated by over 1m and have a left clavicle (PCE-a) in between them (Figure 103). The left ulna specimens (AFH and MSK) are distributed even further apart from one another; nearly 5 metres separate them. The distribution of these elements is therefore less convincing of anatomical positioning than the lower limbs.

Additionally, the case for anatomical positioning becomes weaker still if the positioning of the siding of the limb elements is considered; the right ulna is located in the same area of the major bone group as the left fibula and left clavicle, and part of the left ulna is found with the right fibula and tibia. Not only that but the distribution of right and left extremities across the whole of the bone group, with no clear siding patterning, also lessens the possibility that anatomical positioning is present (Figure 104).

The case for anatomical positioning in the major bone group is weak which supports the comparison between the skeletal element profile at Havnø with the potential profile of either scavenged remains or secondary burial. Scavenging would be likely to cause the bones to be disarticulated and commingled as would secondary burial involving collecting and depositing the bones in the midden. However, if the remains were a result of excarnation on the midden with the residual bone becoming incorporated into the shell matrix, then a degree of anatomical positioning could be expected. As this is not the case, the possibility that the remains were excarnated on the midden themselves is reduced.

7.9 Bone diagenesis

In order to further examine the possibility that the human remains at Havnø were excarnated (either on the midden or elsewhere) it has been possible to apply a new technique, developed as doctoral research by Tom Booth, University of Sheffield (Booth 2014), using microscopic analysis of thin sections of bone to detect diagenetic changes characteristic of different burial treatments. The premise of the technique is that when a body decomposes, bacteria, which originate from putrefaction in the body's organs, expose the bones to biogenic attack. Funerary practices such as excarnation, embalming and secondary burial affect the amount of bacteria present and the ease with which they can access the bone to carry out this attack. A body which had been subject to such funerary process would be expected to exhibit better preserved bones with less evidence of biogenic attack than a body which was inhumed.

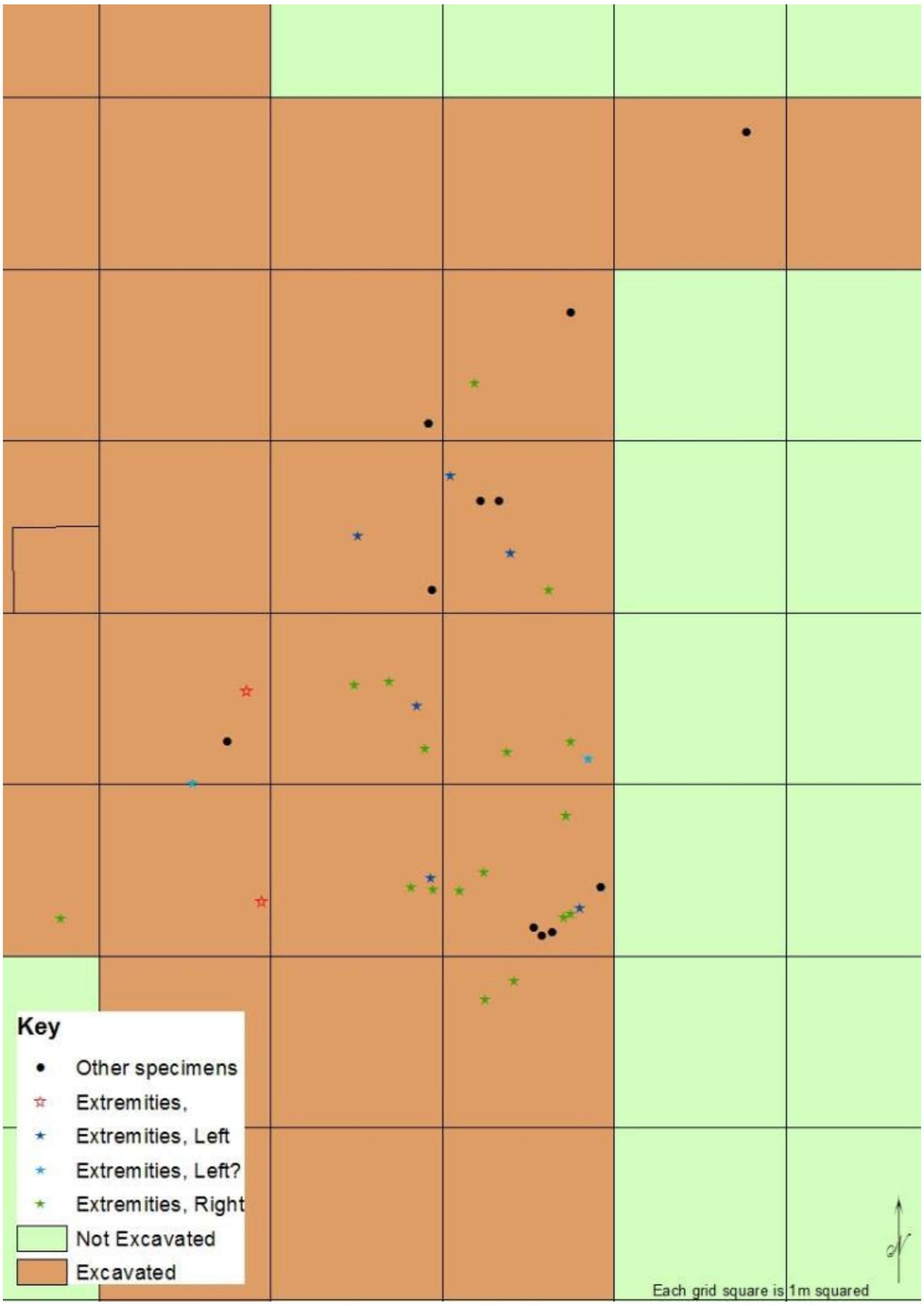


Figure 104: Detail of the spatial location of the extremities belonging to adult one at Havnø showing no patterning of right and left sides

Thin section light microscopy was used to observe the histological preservation of the bone as well as staining, inclusions and infiltrations (Booth 2014, 104). Thin sectioning and histological examination were conducted according to the methodology presented by Booth (2014, 99-148).

7.9.1 Sampling of the Havnø assemblage

The bones chosen for diagenetic analysis are listed in Table 25. Left fibula (NSV) and right fibula (LDU-a) were chosen because they are the smaller specimens belonging to two long bones (the favoured skeletal elements for this type of analysis) present in the human bone which was available to sample. Another ulna is held at Copenhagen Zoological Museum and was therefore unavailable for diagenetic analysis. They are also mid-shaft fragments, minimising damage to diagnostic epiphyseal fragments. The juvenile cranial fragments (QQB, VNV and XPG) were chosen because they were all found in different parts of the midden, suggesting that they might be from different individuals or that they might have been subjected to differential taphonomic processes.

The nature of the assemblage at Havnø means that it was impossible to sample the same skeletal element from different individuals, due to there being no repeated elements. At the time of sampling, the refinements to MNI provided by the isotope analysis were also unknown and therefore samples were taken only from adult one in the major bone group and juvenile two in minor bone group 2.

The technique developed to test the diagenetic attack on bone to show burial processes normally favours long bones, but the Havnø assemblage provided an opportunity to consider the differential effect of attack across the skeleton (Booth 2014, 214). It was concluded that in the Havnø assemblage there was no significant relationship between the presence of bacterial bioerosion and skeletal element but that variation of this kind could not be completely dismissed (Booth 2014, 452). The bioerosion observed in the Havnø remains were thought unlikely to result from environmental inconsistencies, preservational biases or skeletal element bias but instead to be indicative of exposure to bacteria resulting from funerary practices (Booth 2014, 451).

7.9.2 Results of diagenetic analysis of the Havnø remains

All of the bones sampled showed some signs of bioerosion but they can be divided into two distinct groups of poorly and well preserved specimens (Booth 2014), which indicates that both primary and secondary interment practices are likely to be present on the midden (Table 25 and Figure 105).

The well-preserved remains; NYA, UBQ-b, OHL-3, PCE-a, QQB, VNV, UBQ-a and XPG, are indicative of very limited exposure to putrefactive bacteria and are likely to be the result of sub-aerial exposure, or excarnation (Booth 2012, pers. comm.). Importantly, these specimens which were well preserved, and likely to have resulted from excarnated remains, come from both adult one and juvenile two.

The poorly-preserved remains; LDU-a, NSV and THE, must have been subject to high levels of attack which is consistent with immediate inhumation of a whole body (Booth 2014). All of these specimens come from adult one in the major bone group.

Bone number	Square number	Bone	Preservation	Treatment?	Individual
NYA	100/99	Ulna	Excellent	Excarnation	Adult 1, marine diet
UBQ-b	98/98	Phalanx	Very Good/Excellent	Excarnation	Adult 1, marine diet
OHL-3	99/99	Metatarsal	Perfect	Excarnation	Adult 1, marine diet
PCE-a	101/99	Clavicle	Excellent	Excarnation	Adult 1, marine diet?
QQB	110/103	Cranium	Excellent	Excarnation	Juvenile 2, terrestrial diet
VNV	111/103	Cranium	Excellent	Excarnation	Juvenile 2, terrestrial diet
UBQ-a	98/98	Metacarpal	Fair	Excarnation??	Adult 1, marine diet
XPG	111/103	Cranium	Fair	Excarnation??	Juvenile 2, terrestrial diet
LDU-a	98/98	Fibula	Fair/Poor	Primary Interment	Adult 1, marine diet
NSV	100/98	Fibula	Poor	Primary Interment	Adult 1, marine diet
THE	97/97	Metatarsal	Poor	Primary Interment	Adult 1, marine diet

Table 25: Summary of results of thin section microscopy to determine bioerosion on Havnø remains (analysis conducted by T. Booth)

All of the samples sectioned showed orange staining caused by iron oxide deposits on the bone from groundwater surrounding the burial and brown staining caused by infiltration of humic acids released by decaying organic material (Booth 2014, 453). These two types of staining being present throughout the Havnø specimens suggests that all of the bones were subjected to similar burial conditions over the period of their deposition (Booth 2014) and hence indicating that if the bones had been transferred to the midden from another interment site it would have been relatively soon after defleshing occurred.

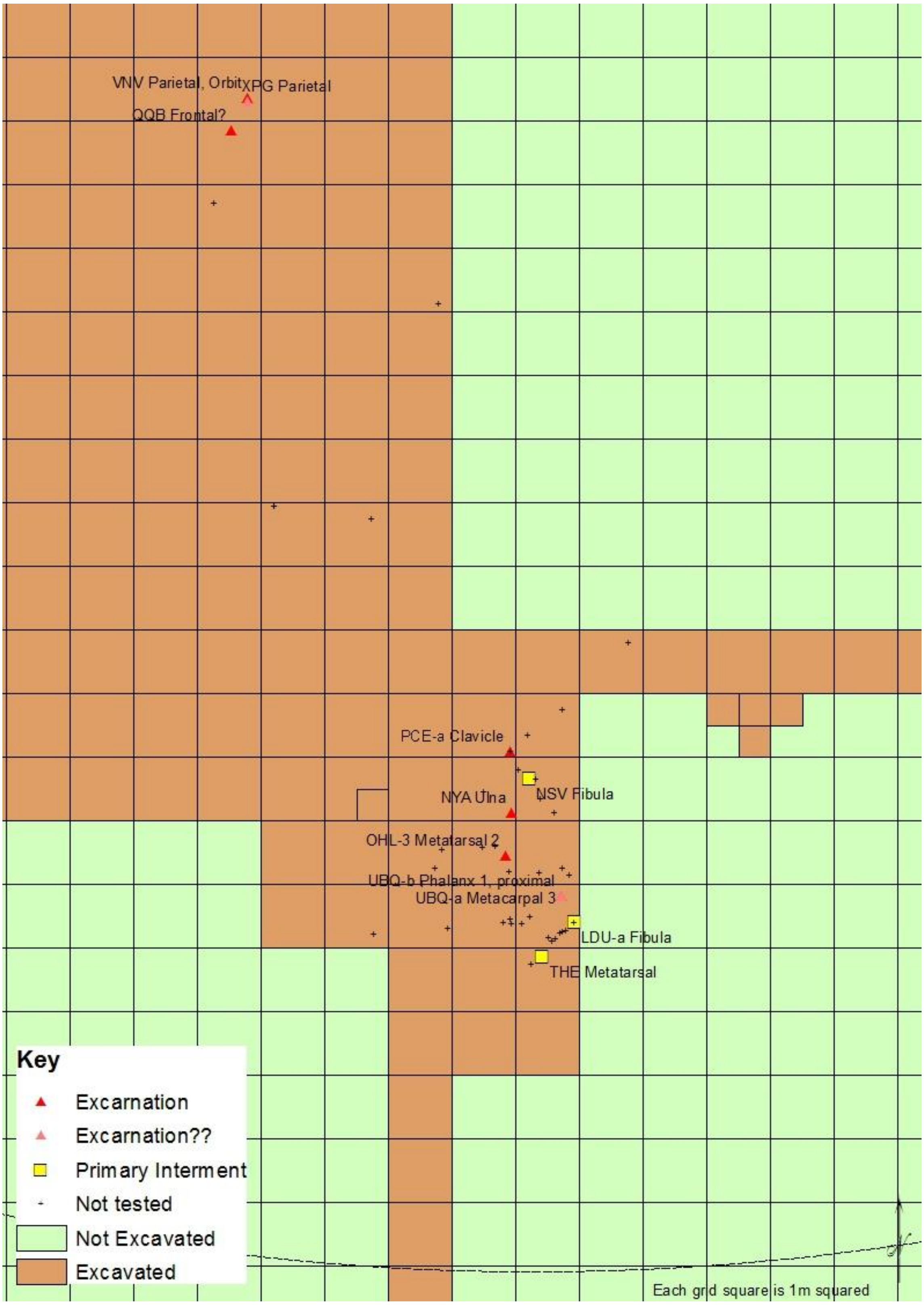


Figure 105: Plan of human remains from Havnø showing burial treatments based on diagenesis analysis

7.9.3 Implications of diagenesis analysis

The three juvenile cranial elements tested all have terrestrial dietary isotope signatures. Dating of another possibly associated cranial fragment (XYB) has provided a calibrated date of 2,909cal BC-2702cal BC (Table 24). Based on the similar location in the midden and commonality of skeletal element it is possible that the three samples tested here (QQB, VNV and XPG) and the radiocarbon dated element (XYB) were all part of the same phase of use, which involved the secondary treatment of a juvenile skull which had been skeletonised quickly, possibly through excarnation.

Adult fibulae fragments (LDU-a and NSV) from the major bone group both appear to have been primary interments based on their diagenetic signatures showing extensive attack. In contrast, ulna fragment (NYA), also from the major bone group, displays a different level of diagenetic attack than the fibulae fragments, being much better preserved, suggesting that the ulna was subject to excarnation, or another process which skeletonised the arm quickly.

There are two possible interpretations which could apply to the fibulae (LUD-a and NSV) and ulna (NYA). The first is that the three specimens are from two different individuals who ate the same diet but were subject to different burial practices at death, one being excarnated on the midden and the other being interred within it. If this was the case then the MNI at the site would need to be further increased to six; 3 adults, 2 juveniles and 1 adolescent.

The second possible explanation is that the specimens are from the same individual who was provided a combination of funerary processes. The lower half of the body and limbs may have been subject to slow decomposition of soft tissue, possibly interment, while the upper part of the body and upper limbs were skeletonised quickly perhaps by being left exposed.

Radiocarbon dating of a piece of the ulna (OTD) which re-fits with (NYA) places it at 4,651cal BC – 3,736cal BC which closely corresponds to a metatarsal fragment also with a marine isotope signature dating to 4,630cal BC – 3,716cal BC. The overlap of these dates and the demonstrated similarity in diet suggests that the main group of adult human remains, from which both the poorly preserved fibulae and the well preserved ulnae originate, could represent one individual who was subject to a combination of processes which caused some parts of their body to become skeletonised quickly and others to be preserved for longer.

The spatial distribution of the remains in the major bone group suggested that the lower limbs showed more likelihood of anatomical positioning in the midden than the upper limbs (Figure 103). This is partially supported by the bone diagenesis analysis which indicates that the two fibulae and one metatarsal (THE) were inhumed, which would correspond to their possible anatomical positioning in the midden (Figure 105). Contrastingly, the diagenesis interpretation that the specimens from the upper limbs were excarnated supports the spatial distribution of the specimens which suggested that they were less likely to be in anatomical position (Figure 103).

However, metatarsal (OHL-3) complicates this picture; it was shown by diagenesis analysis to be well preserved, implying that it had been excarnated, or skeletonised, quickly, unlike the other metatarsal tested (THE). Further testing of the other extremities in the major bone group would allow assessment of the proportion of extremities which were poorly preserved and well preserved and whether these correspond with upper and lower limbs or not. This might help to clarify whether the lower part of the body was subject to different processing than the upper.

7.10 Burial processes at Havnø shell midden

Examination of the Havnø human remains assemblage using traditional osteological techniques combined with new applications of scientific techniques and detailed spatial analysis, has shown that the remains from at least five individuals were incorporated into the midden in several phases.

The earliest burial activity at the site occurred during the Mesolithic/Neolithic transition, c.4,600cal BC - 3,700cal BC, and consisted of a burial practice which deposited a variety of skeletal elements including limbs and extremities, but no cranial, rib and vertebral elements, in a fairly closely packed group within the midden. These remains appear to have been from one (or possibly two adults) who ate a predominantly marine diet. The omission of spinal and torso skeletal elements may not be the result of preservational or identification bias, because no fragments of these elements were identified using ZooMS analysis. Therefore, it can be inferred that these parts of the skeleton, which act as an anchor (Behrensmeyer 1983, 98) and are amongst the final parts of the skeleton to completely disarticulate, were probably not present at this site. The skeletal elements which are present in the Havnø assemblage are likely to have been actively selected and brought to the site for deposition after some degree of defleshing had occurred, leaving the partially decomposed trunk of the skeleton behind elsewhere. It is unlikely that these bones were subject to animal scavenging due to a complete lack of gnaw marks and instead, due to their close spacing in the midden, probably represent an intentional deposition into the midden as part of a secondary process.

The preservational signature present on the bones from this early burial shows evidence for both excarnation practices and primary interment suggesting that a complex system of funerary practices were employed during this time. Either two individuals who led similar lives (given the similarity in diet) were treated to opposed burial treatments; one to interment and one to excarnation or one person was subjected to a string of processes which left differing taphonomic markers on different parts of the skeleton. The osteological evidence, spatial relationships, dating and dietary isotope analysis point to the fact that it is indeed one adult individual present in this burial. Given this wealth of evidence an interpretation of a single person whose body was subjected to both excarnation and interment funerary practices would be the most convincing explanation.

Within the major bone group containing the early adult burial there was a juvenile cranial fragment found (LDY-2). This fragment has been dated to c. 3,954cal BC – 3,795cal BC which although not completely corresponding to the earlier burial does fall within the outer limits of the standard deviation. It is possible that this juvenile specimen is broadly contemporary with the adult burial, although would appear to represent a contrasting burial practice given the fact that it is an isolated piece of cranium. Perhaps further excavation to the southwest of the excavated trench might yield additional juvenile remains associated with this phase of use.

A later phase of burial took place in the Neolithic around 2,900cal BC – 2,700cal BC, when juvenile crania were excarnated on the midden. These cranial remains belonged to people eating a terrestrial diet. The differences in the skeletal specimens present in the two phases, with crania largely missing from the earlier phase but making up the entire record from the later phase, together with the bioerosion consistent with excarnation, support the hypothesis that differential burial practices were in place at these different times. With no evidence for juvenile skeletal specimens other than the cranial fragments it has to be concluded that the child's skull was intentionally brought to the shell midden site to be deposited after primary funerary treatment had been completed elsewhere, although further excavation to the east of the midden might reveal further juvenile remains.

The final burial phase present at the site involves a second adult individual in minor bone group 1 dated to 2,862cal BC – 2,512cal BC. The patella showed that this individual had a primarily terrestrial diet and the presence of a patella and mandible imply that these elements were from the early stages of disarticulation of a skeleton. There is no further evidence of this individual in the midden available at this time. Therefore, based on the evidence currently available, it is possible that the second adult individual was excarnated on the midden for partial disarticulation to take place before being removed elsewhere for secondary treatment, leaving only remains that had already become disassociated from the body.

The fifth individual is represented by an adolescent radius with little more being known about how this individual fits into the overall picture at Havnø because it was only available for identification in Denmark and could not be subject to further analysis as part of this study.

Further excavation of the midden to the southwest may yield more evidence of the second juvenile and further investigation in the east of the midden might uncover identifiable human remains, perhaps belonging to the early adult burial or an entirely new burial. More dating on the main human bone group could help to clarify whether this is the remains of a single individual.

What is clear is that that the shell midden was an important place for burial in the late Mesolithic and remained so into the Neolithic period and possibly into the Bronze Age. While the reasons behind the placement of human remains on the midden in these different periods may or may not have been the same, it is clear that they were played out with varying burial practices involving primary interment and excarnation. It seems that the earlier burial activity at the site involved secondary burial treatments which deposited the skeletal elements within the midden intentionally, whilst the later burial phases involved the primary treatments of the body which resulted in the bones being incorporated into the midden more accidentally as a result of disarticulation of the skeleton.

Chapter Eight: Discussion

8.1 New approaches to disarticulated human remains in shell middens

This study aimed to critically investigate the evidence for intentional placement of disarticulated human remains in shell middens. A series of six potential burial profiles which are based on taphonomic knowledge of the processes, both human and non-human, which affect bone assemblages have been presented. These potential profiles have then been applied as comparisons to real archaeological examples of disarticulated human bone assemblages from shell middens.

The investigation of case studies presented in this research makes it possible to gauge to what degree intentional placement of disarticulated human remains in shell middens can be determined. The results show that although it is not possible to be certain that a specific human funerary process caused the pattern of remains, it is possible to use a combination of analyses to draw more informed conclusions about the taphonomic history and possible intentional placement of these remains into shell midden sites.

8.1.1 Comparison of case study sites

In this study four case study sites have been presented: three from Scotland; Carding Mill Bay, An Corran and Cnoc Coig, Oronsay; and one from Denmark, Havnø (Figure 106). Both Carding Mill Bay and An Corran are small shell middens which are located at the base of a cliff, in a natural rock shelter formation, while Cnoc Coig and Havnø are both larger open air midden sites located close to the ancient shoreline.

An Corran, Cnoc Coig and Havnø all have evidence of Mesolithic occupation and development of the midden which has been determined both from typological assessment of artefacts and radiocarbon dates. An Corran has radiocarbon dated bevel ended tools ranging from the 7th millennium BC to the 3rd or 2nd millennium BC (Saville et al. 2012, 74) and bone points which have been dated to the Iron Age. The long chronological span at An Corran shows a long and complex history of use which included the incorporation of the human remains into the shell matrix during the Neolithic in the 4th millennium BC.

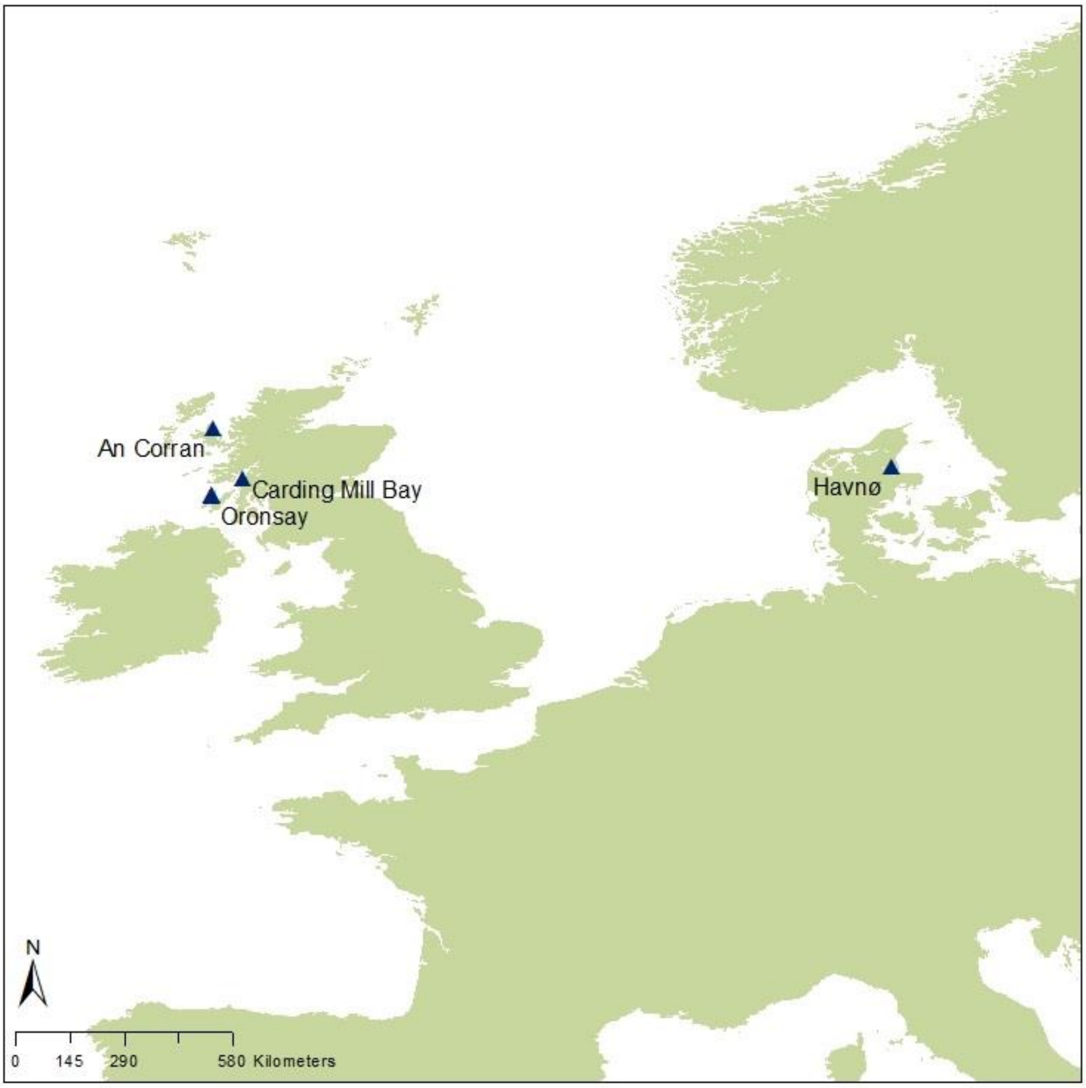


Figure 106: Location of the four case study sites

At Cnoc Coig radiocarbon dating on shell provides dates in the 6th millennium BC while charcoal samples date to the 5th millennium BC (Milner and Craig 2009, Figure 15.8). The human remains found in the shell midden at Cnoc Coig have been calibrated to the transition to agriculture at around 4,000 BC (Milner and Craig 2009, Figure 15.8). As with An Corran, the dates on the human remains are later than the expected use of the shell midden indicating that the inclusion of the human bone is an intrusive act on the midden.

Havnø has evidence for continued build-up of the shell midden in both the Mesolithic and Neolithic periods with distinct shell matrices defining the stratigraphy and evidence of both Mesolithic Ertebølle and Neolithic Funnelbeaker pottery (Andersen 2008, 4). The dates on the human remains from Havnø which were obtained as part of this study show that the main bone group deposit at the site derives from the late Mesolithic, possibly into the early Neolithic. There are then two further phases of funerary activity at the site in the 4th millennium BC and the 3rd millennium BC.

The early shell midden context at Carding Mill Bay has been dated to the early Neolithic with radiocarbon dates on shell, charcoal and bone and antler tools ranging from c. 4,000 BC- c.3,500 BC, although it is possible that there is a slightly earlier late Mesolithic date to the earliest parts of the midden (Milner and Craig 2009, 174). The human remains found in the earlier shell midden context have been radiocarbon dated to a similar Neolithic timeframe as the midden itself in the second half of the 4th millennium BC. The Carding Mill Bay site was used for a series of later funerary deposits as a further date on a human metatarsus from the fissure context at around 3,000 BC and the presence of a Bronze Age cist burial at the site demonstrate.

A summary of the dating of each shell midden and their respective human remains deposits shows the long use of An Corran site with intrusive Neolithic burial remains into the midden (Figure 107). Additionally, it is clear that both Carding Mill Bay and Cnoc Coig middens were in use for occupation and shell build up prior to a later phase of use in which the human remains became incorporated into the midden. Whilst there are no available radiocarbon dates on midden material for Havnø it is known that the occupation of the midden occurred prior to and after the inclusion of human remains into the midden in a similar pattern to that at An Corran.

Looking at the radiocarbon dating evidence it also seems that all of the sites except Cnoc Coig had an initial phase of funerary depositions followed by a hiatus in placement of human remains before being used for further mortuary activity (shown in Figure 108). Of course not all of the human remains at each site have been dated and it may be that this hiatus is a construct of the radiocarbon dating sampling rather than funerary use. However, at Carding Mill Bay the evidence for a hiatus is convincing due to the distinct later burials being contained not within the shell midden but within the fissure deposit, unspecified midden and cist burial. Similarly, at Havnø the spatial location of the later human remains in a separate area to the north of the earlier main bone group supports the presence of differing treatment and a possible hiatus in burial. Additionally, at Havnø the different skeletal make-up of the two assemblages; the earlier burial containing distal limbs and extremities compared to the later assemblage containing only cranial remains, further emphasises that the hiatus in radiocarbon dates is evidence of a real hiatus in use of the midden for burial purposes. At An Corran the stratigraphy is less clear, due to the rescue nature of the excavation, and the only way to clarify whether there was a hiatus in use would be to conduct further dating of the human remains assemblage.

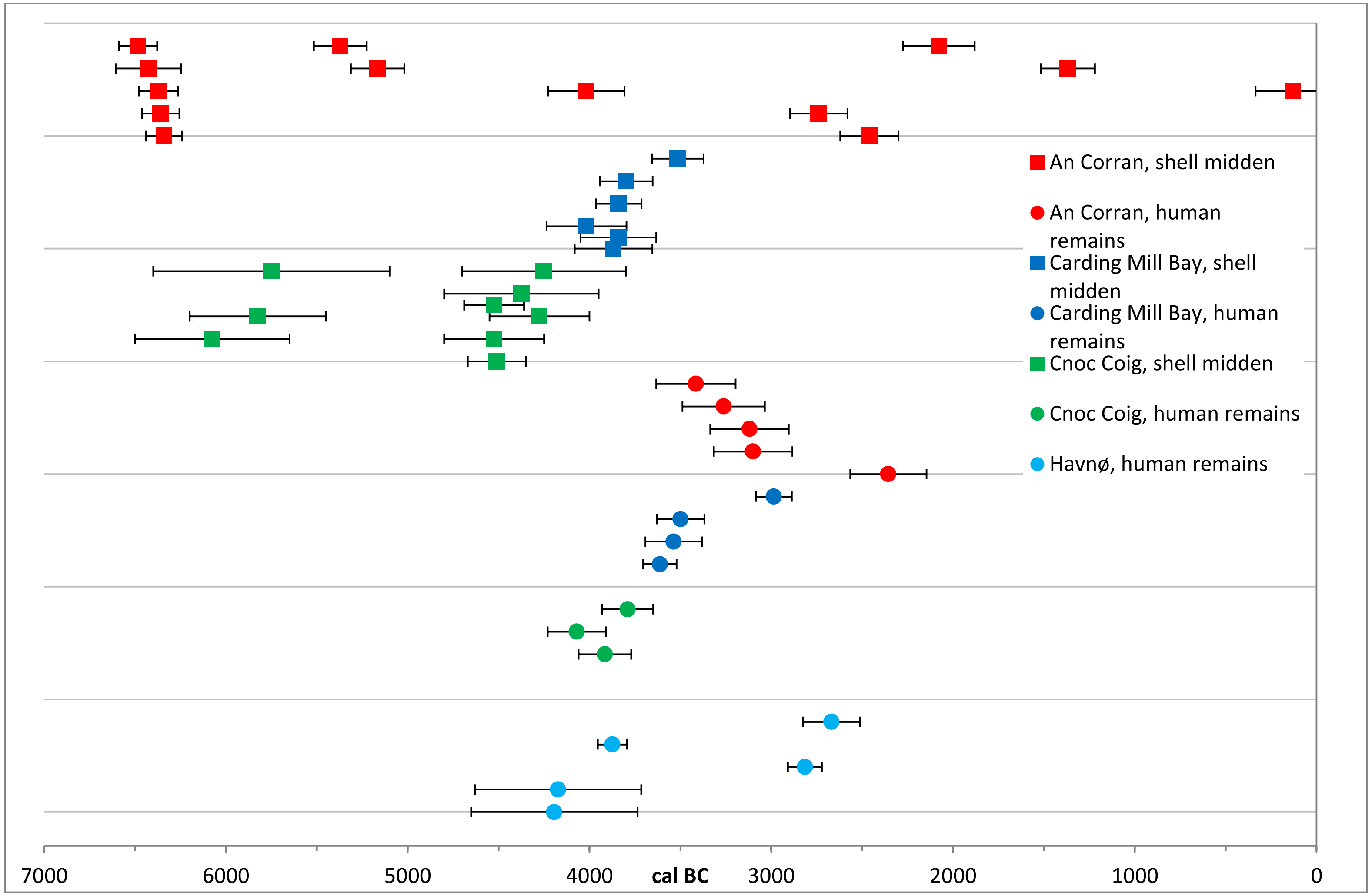


Figure 107: Chart summarising the radiocarbon dates for the midden occupations and human remains of each of the four case study sites

Given the strong likelihood that three of the four case studies provide evidence of an initial phase of burial use of the shell midden, followed by a hiatus and then later mortuary use of the site it appears that the evidence from Cnoc Coig is anomalous to this pattern (Figure 108). This could be simply that there is a different pattern of use present at this site, which might be expected given that this midden presents no evidence for later occupation of the midden. However, the radiocarbon dates that have been obtained on the human remains from Cnoc Coig were all taken from bones contained within the major bone groups (2 and 3) which have been interpreted as being distinct deposits into the midden. The other human bone at the site which was found in minor bone groups, as isolated loose bones or in the newly identified assemblage from trench U outside of the midden, has not been dated. It is possible that all or some of these human bones are evidence of later deposits at the site, and therefore these might indicate some later mortuary behaviour present at Cnoc Coig. As at An Corran, this will only be clarified through further dating of the human bone assemblage.

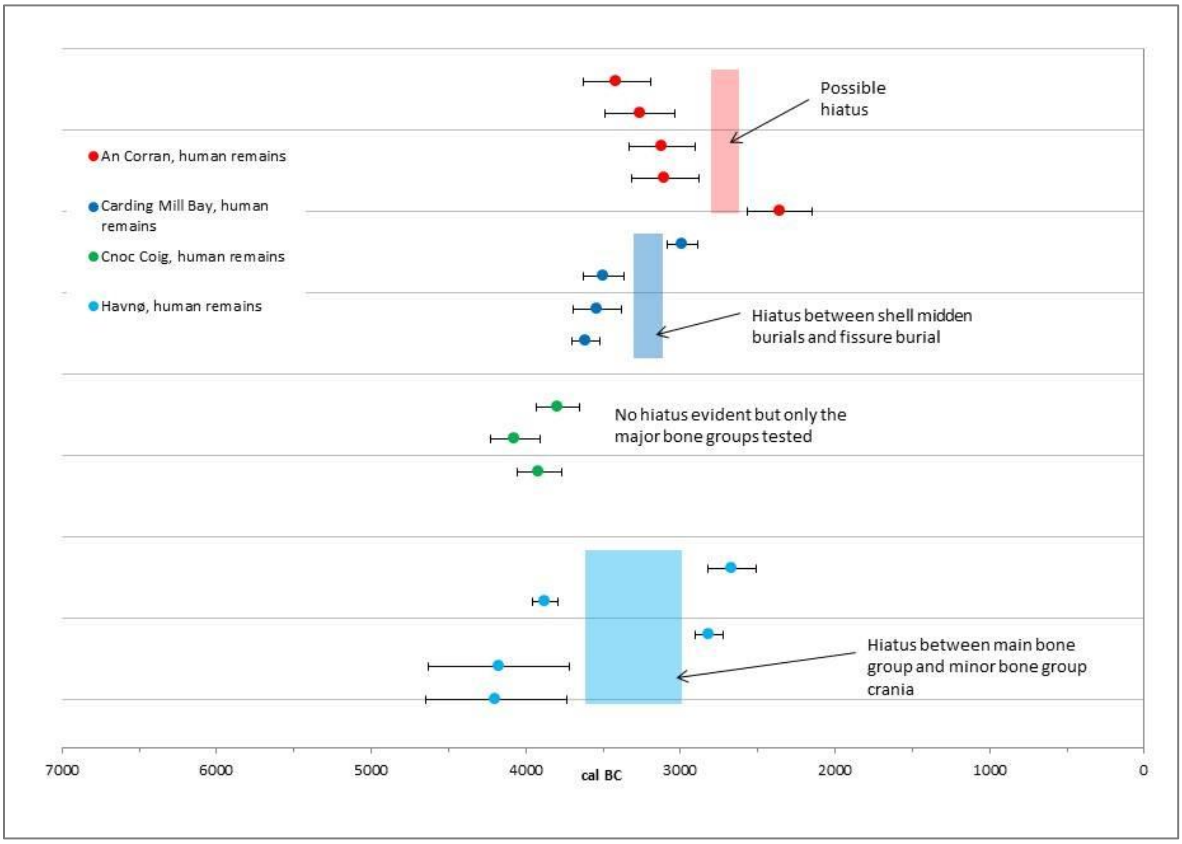


Figure 108: Dates of human remains at all four case study sites showing possible hiatuses in use of the sites for human burial

The case studies which form this study are therefore all unique but offer good grounds for comparison and contrast of their evidence. They are a mixture of rock shelter middens and open air middens dating from the late Mesolithic through the transition to the Neolithic and in the case of Carding Mill Bay and An Corran use of the sites continues into the Bronze Age and Iron Age respectively. What they all have in common is that the presence of human remains in the middens themselves is a later inclusion to the site, rather than being associated with the initial phase of occupation and accumulation of the shells.

8.1.2 Summary of taphonomic histories from case study sites

Through the close examination of the human remains at each of the four case study sites a possible interpretation of the burial processes leading up to their inclusion in the shell middens was presented. In all of the cases the possibility that non-human taphonomic processes were the cause of the placement of human remains in the midden has been considered. It is impossible to rule these non-human factors out entirely, although there is no firm evidence to show that they were the cause. Therefore, the possible human burial taphonomy is discussed for each case study before these will then be compared and contrasted with each other.

At An Corran the skeletal elements found; extremities, vertebrae, ribs, and more importantly those that are missing; crania and long bones, indicate that it is likely that entire bodies were taken to the site and laid out on the shell midden located at the back of the natural rock shelter. There is no evidence of animal gnawing or weathering of the bones suggesting that defleshing occurred quickly and that the cadaver was protected from scavengers and the elements. Once the bones were skeletonised selected elements were removed from the midden and are likely to have been taken elsewhere as part of secondary funerary practices. The bones that have been found in the midden are those that became incorporated into the shell matrix as a result of being residual to the secondary funerary treatment that took place.

At Cnoc Coig there were 3-5 bodies at the site which were subject to mortuary practices during which the bodies were defleshed and broken up, although the exact means of this disarticulation is not clear. It is possible that the processing of the bodies took place in or around the vicinity of trench U as well as on the midden itself. When the bodies had been broken up the majority of the bones were collected, leaving some residual bone to become incorporated into the midden context and in trench U. There seems to have been an active secondary placement of extremities from the hands and feet into the midden matrix along with the flipper of a seal, implying some connection between the two (Meiklejohn et al. 2005). The remaining bones that had been collected have not been found and are likely to have been removed from the site for secondary burial rites elsewhere.

At Carding Mill Bay, comparison of the human bone assemblage from the shell midden contexts with the assemblages from the other contexts at the site, particularly the cist burial, has allowed a firmer assertion that the remains are the result of secondary processing rather than being a disturbed inhumation burial. In the earlier shell midden there is no evidence of animal gnawing and only a little indication of weathering of the bones. Like at the other sites this again suggests that the body was skeletonised quickly and in a protected environment, away from the worst of the effects of weather and animals. The very small number of bones in the earlier shell midden and predominance of hands and feet suggest that selected bones were taken to the site in a disarticulated state, where they were then placed on, or incorporated into, the midden as part of a secondary funerary rite.

The later shell midden at Carding Mill Bay seems to have had at least three individuals placed on the midden for decay and disarticulation to occur. The majority of the bones were then collected and removed from the site, with only residual bone becoming incorporated into the later shell midden. Presumably, the bones that were removed from the site were subject to secondary burial treatment elsewhere.

At Havnø the initial burial phase at the site probably saw a single individual being subject to a complex burial treatment which caused preservational signatures on the bones similar to both excarnation and primary burial. The burial practices which caused this are most likely to have occurred somewhere other than the midden site, as the missing trunk bones from the vertebral column and ribs imply that this part of the body was never present at the site. It is possible that the lower half of the body was buried, causing the bone to be poorly preserved, indicative of primary burial, whereas the upper part of the body was not buried and therefore preserved well, as if from excarnated remains. An alternative explanation for this pattern of bone preservation could be that the upper parts of the body were intentionally defleshed quickly, and therefore mimic the preservational signature of excarnated bone, whereas the lower limbs were not actively defleshed. Subsequently, selected parts of the body were removed from the site where this primary activity took place and brought to the shell midden at Havnø. The close spatial grouping of these bones suggest that they were then intentionally deposited into the midden in a disarticulated state, as a secondary burial process.

Havnø shell midden was then used again for a later phase of burial where juvenile cranial fragments became incorporated into the midden. These are so fragmentary and low in number that it is difficult to conclude by what process they became incorporated into the midden but it would seem to be a notably different process or funerary practice than from the earlier burial, where no cranial remains are present. A final later phase of burial involved the incorporation of an adult patella and possibly mandible (based on their close spatial proximity to each other), into the midden, but again the exact process leading to this is unclear due to the small number of specimens.

The skeletal element profiles of the case studies examined as part of this study point to complex burial practices which did not require the complete intact inhumation of an individual but instead involved complex processing of the body in secondary funerary rites. At An Corran, in the loose bone, minor groups and trench U at Cnoc Coig and in the later shell midden at Carding Mill Bay it appears that decomposition of the whole body was followed by selection of skeletal elements for secondary treatment resulting in some residual bones, like the smaller extremities, being left behind and becoming incorporated into the shell middens. The skeletal element profiles of these assemblages have been compared to the potential profile of a secondary burial (Figure 109). It is notable that at all three sites it is the combined presence of extremities, which disarticulate early in the decomposition process, alongside bones from the trunk like the ribs and vertebrae, whose articulations remain until towards the end of the process, which suggest that a complete body was present at the site.

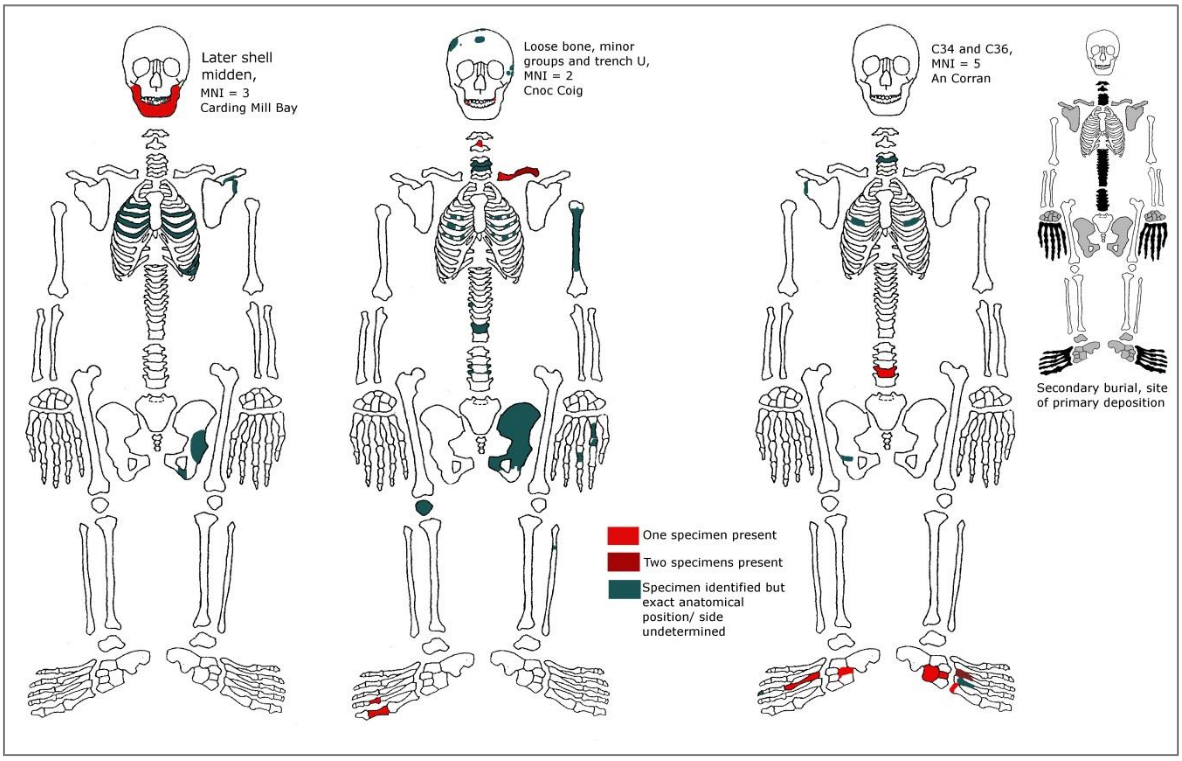


Figure 109: Skeletal element profiles of Carding Mill Bay, Cnoc Coig and An Corran compared to the potential profile from the primary placement location of a secondary burial

Further evidence of secondary burial practices is also suggested at Havnø, in the major bone groups at Cnoc Coig and in the earlier shell midden at Carding Mill Bay. However, the skeletal element profiles (Figure 110) show that these are more likely to be the result of intentional placement of already disarticulated bones into the middens rather than whole bodies having been present at the site as in the examples shown in Figure 109. There are fewer trunk bones in the skeletal profiles from Figure 110 and they contain a noticeably high proportion of extremities. At Cnoc Coig and Havnø the detailed spatial data that is available supports the suggestion that these remains were intentionally placed into the midden in a confined area, likely to be a single intentional deposition forming a secondary funerary rite. The spatial evidence in the earlier shell midden at Carding Mill Bay is less clear but the prevalence of extremities and lack of any other substantial remains seems to make this assemblage similar to the pattern of deposition at the other two sites.

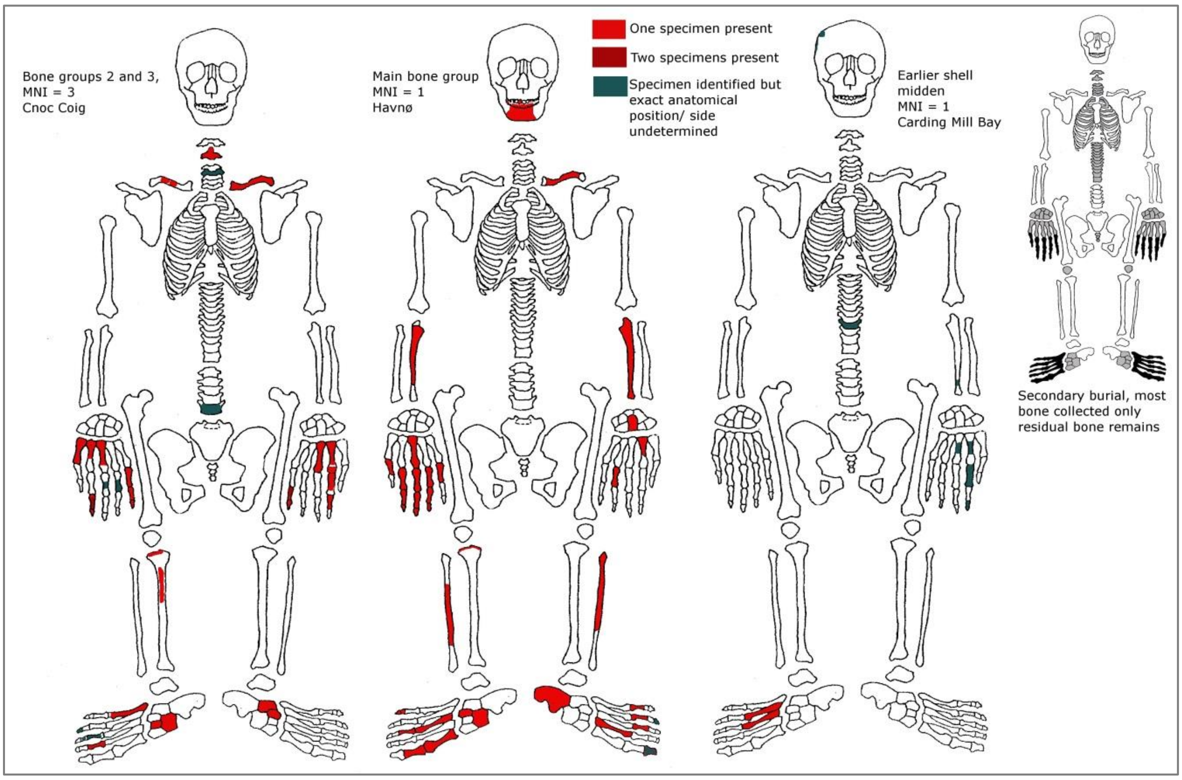


Figure 110: Skeletal element profiles of secondary burials at Cnoc Coig, Havnø and Carding Mill Bay compared to the potential profile from a secondary burial where most bone was removed

The skeletal remains contained within shell midden contexts at these sites present a revealing distribution of human remains. They are by no means representative of the bones contained within a whole skeleton, nor of the amount of bones that would be expected from several individuals despite the fact that the environment in a shell midden is conducive to excellent bone survival due to the alkaline environment produced by the calcareous shells as they break down (Sobolik 2003, 25). This suggests that if whole bodies had been interred in these middens, much larger numbers of bones would be expected to survive. However, it must be remembered that none of these sites has been fully excavated, and therefore some absence of bone might be expected. Given the survival of small bones of the hands and feet in a near intact state it is hard to explain the absence of robust long bones like the femur other than to attribute this to intentional selection by humans.

8.1.3 Prevalence of extremities in shell middens

One of the major similarities seen across the four case studies is the prevalence of bones from the extremities in the assemblages. Although the intrinsic nature of these small cortical bones suggests that they should survive well (Darwent and Lyman 2002, 359), in real archaeological examples of preservational studies they are often under-represented (Cox and Bell 1999, 945; Henderson 1987; Nawrocki 1995, 62; Waldron 1987).

There is some suggestion that shell midden contexts in particular provide an environment which is more conducive to the survival of extremities than other types of archaeological site. The shape of the shells directs water away from the small bones as if it were an umbrella, causing limited change in pH values and increasing the chances of bone survival (Reitz and Wing 1999, 117). Additionally, the structure of the shell protects the extremities from fragmentation through trampling or consolidation of the matrix (Reitz and Wing 1999, 117-8). It is therefore possible that there is a slight skew in favour of extremities surviving on shell midden sites.

However, given the obvious lack of some other elements which are robust and recognisable, like the long bones, from all of the case studies it does appear probable that they have been deliberately removed from the shell midden as it is very unlikely that so much of the rest of the skeleton would be lost.

The skeletal assemblages from each of the four case studies can be compared by calculating the percentage representation of each class of elements (skull, vertebral column etc.) within that contexts' assemblage as a whole. The specimen numbers have been adjusted for MNI and then divided by the total specimen numbers for that context (Table 26).

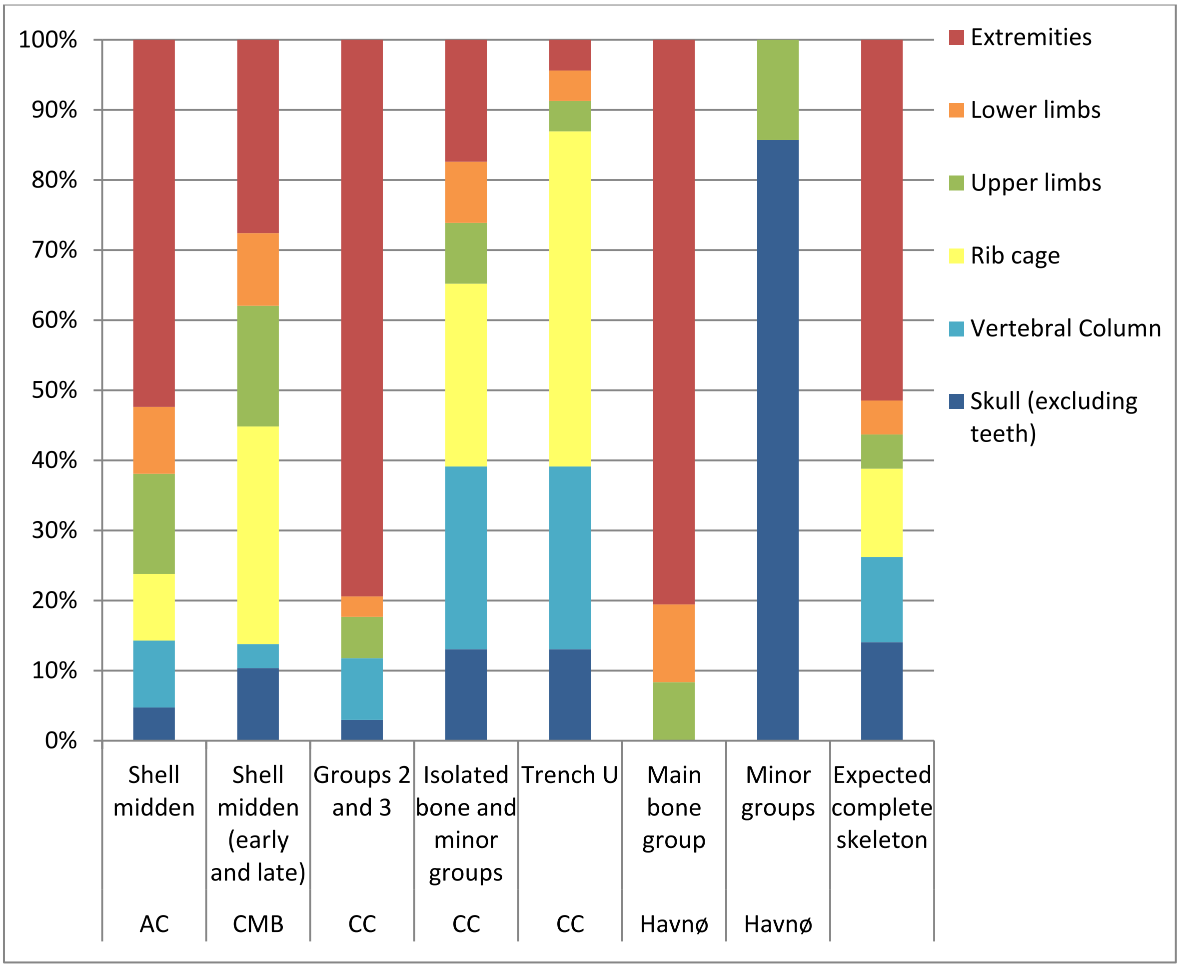


Figure 111: Frequency diagram showing percentages of skeletal elements belonging to each area of the skeleton in the case studies. Percentages were calculated using a specimen count which had been corrected for MNI. AC= An Corran, CMB= Carding Mill Bay, CC= Cnoc Coig

The prevalence of extremities is most clear in Groups 2 and 3 at Cnoc Coig and in the main bone group at Havnø, where in both cases the extremities account for around 80% of the assemblage (Figure 111). The assemblage at An Corran is comparable to the expected number of extremities within a complete skeleton with over 50% of the assemblage accounted for by extremities (Figure 111). The difference between Groups 2 and 3 and the isolated bone and minor groups at Cnoc Coig, is clearly evident in Figure 111. There are high numbers of extremities in groups 2 and 3 but no elements of the rib cage present whereas ribs make up 48% of the assemblage from trench U. It is also evident that there is a distinct difference in the make-up of the main bone group assemblage at Havnø and the minor bone groups, which is supported by the different dates and diets displayed by these remains.

Site	Context	MNI	Number of Specimens / (Percentage of assemblage)						
			Skull (excluding teeth)	Vertebral Column	Rib cage	Upper limbs	Lower limbs	Extremities	Total
An Corran (AC)	Shell midden	5	0.2 / 5%	0.4 / 10%	0.4 / 10%	0.6 / 14%	0.4 / 10%	2.2 / 52%	4.2
Carding Mill Bay (CMB)	Shell midden (early and late)	3	1 / 10%	0.33 / 3%	3 / 31%	1.67 / 17%	1 / 10%	2.67 / 28%	9.67
Cnoc Coig (CC)	Groups 2 and 3	3	0.33 / 3%	1 / 9%	0 /0%	0.67 / 6%	0.33 / 3%	9 /79%	11.33
Cnoc Coig (CC)	Isolated bone and minor groups	3	1 / 13%	2 / 26%	2 /26%	0.67 / 9%	0.67 / 9%	1.33 / 17%	7.67
Cnoc Coig (CC)	Trench U	2	1.5 / 13%	3 / 26%	5.5 / 48%	0.5 / 4%	0.5 / 4%	0.5 / 4%	11.5
Havnø	Main bone group	1	0 / 0%	0 / 0%	0 / 0%	3 / 8%	4 / 11%	29 / 81%	36
Havnø	Minor groups	4	1.25 / 86%	0 / 0%	0 / 0%	0.25 / 14%	0 / 0%	0 / 0%	1.5
Expected complete skeleton		1	29 / 14%	25 / 12%	26 / 13%	10 / 5%	10 / 5%	106 / 51%	206

Table 26: Summary of the skeletal element profiles at the case study sites. Percentages have been calculated from the specimen counts and adjusted for MNI in each context. The percentage makeup of a complete skeleton has been included for comparison

The prevalence of extremities found most notably in Cnoc Coig groups 2 and 3, Havnø main bone group and possibly also present at An Corran is due to more than just favourable preservation at a shell midden. The placement of some of the Cnoc Coig bones in association with a seal flipper points to intentional and selective treatment of the extremities at this site. A similar degree of intentional placement is indicated at Havnø by comparable proportions of the assemblage being made up of extremities, a much larger proportion than would be expected from a complete skeleton.

It is suggested here that the possible preservational bias towards extremities, which is specific to shell morphology and shell midden sites can be seen in the assemblages considered for this study although it is not the high proportions of extremities which show this. Instead it is suggested that the extremities which have been analysed for this study are largely in a less fragmentary state than the other skeletal elements examined, which supports the suggestion (Reitz and Wing 1999, 117-8) that the shell morphology might protect these smaller bones from the effects of trampling. Fragmentation of the bone specimens was recorded during the analysis of the skeletal remains with specimens being classified as complete or almost complete (between 75% and 99% complete) and the results are summarised in Table 27. In 59 out of 77 cases (77%) the extremities were classed as complete or nearly complete, whereas the upper and lower limbs were only classed as such in 43% and 30% of cases respectively (Figure 112).

	Skull (excluding teeth)	**Vertebral column**	**Rib cage**	**Upper limbs**	**Lower limbs**	**Extremities**
Complete / nearly complete	1	2	0	6	3	59
Total specimens	17	12	7	14	10	77
% nearly complete	6%	17%	0%	43%	30%	77%

Table 27: Table summarising the completeness of specimens from each skeletal element group across all four case studies. Note however that the non-shell midden contexts from Carding Mill Bay have been omitted

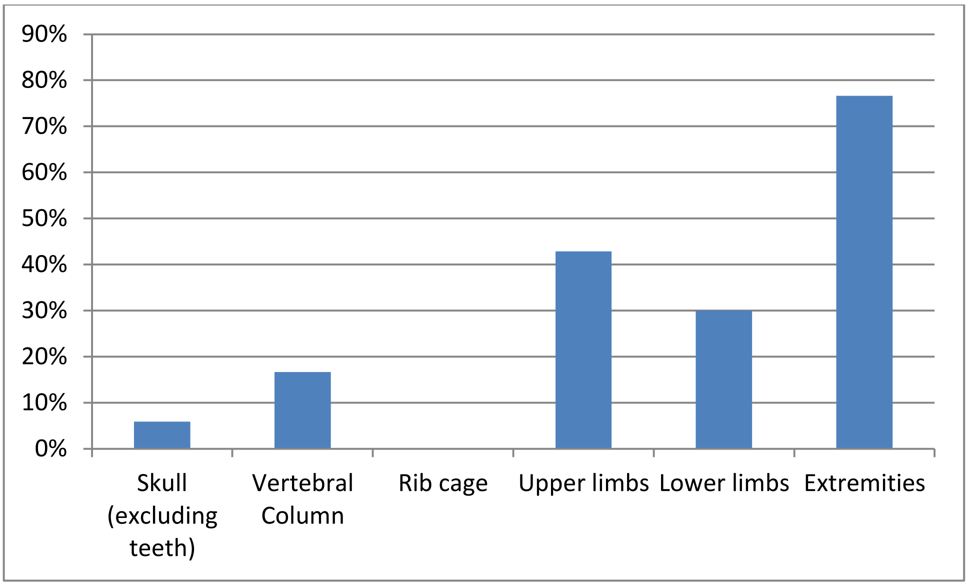


Figure 112: Graph showing the proportion of specimens belonging to each part of the body which were classified as complete or nearly complete during analysis across all four case study sites

8.2 Methodological challenges of dealing with disarticulated remains and shell middens

Whilst there is convincing evidence that the patterns of skeletal elements found within all of the case study sites considered here might be the result of intentional human taphonomic processes, likely to have been funerary practices, the limitations of this approach must also be highlighted.

The fragmentary nature of the remains makes traditional osteological analysis challenging, with conclusive ageing and sexing of the skeletons often impossible. This means that the specific details about who the individuals were is not always possible to ascertain and limits the potential for elaborating on these types of interpretation. Additionally disentangling which skeletal specimens belong to individual skeletons is also a challenge, due to the disarticulated and commingled nature of the bones. Refitting analysis, like that applied in this study at Havnø and by Meiklejohn et al. at Cnoc Coig (2005, 91-2), does help to clarify whether there are links between skeletal elements or not and the application of isotope analysis to distinguish individuals, as applied at Havnø, further aids the understanding of how commingled the assemblage is.

The potential skeletal profiles created for this study are dependent on generalisations about the taphonomic signatures of certain processes. Therefore, their comparison to the skeletal element diagrams in order to postulate on the possible taphonomic processes which affected the case study assemblages is prone to over simplification. However, these are useful generalisations as they allow discussion of the potential processes leading to the inclusion of disarticulated human remains in shell midden. This type of discourse is often lacking from shell midden studies as these remains are considered too fragmentary to warrant detailed examination, or the poor relations to more detailed discussion of articulated inhumations. But, whilst there are general patterns that can be expected of non-human taphonomic processes, like the order of disarticulation of a decomposing skeleton (Andrews and Cook 1985; Hill 1979; Hill and Behrensmeyer 1984), or the expected targeting of specific skeletal elements by scavengers (Berryman 2002; Behrensmeyer 1983; Binford 1981; Haglund et al. 1989), the reality of the situation is not normally so simple. In reality there can be many taphonomic factors that affect the decomposing body, both human and non-human, and disentangling these from an archaeological assemblage will never achieve fully conclusive results. For example, a hypothetical situation involving many taphonomic processes considered in this study could be:

> A body is laid out by human action to be excarnated on the shell midden and is then subject to limited animal scavenging, removing a single limb before the body was protected by humans to prevent further loss. At the same time general soft tissue decomposition causes skeletonisation and some disarticulation of the skeletal element. Skeletal elements which are exposed early might then be subject to sub-aerial weathering causing cracking and bleaching of the bone. After a set period of being laid out, human action might then involve returning to the body to manually remove any remaining flesh and cut any articulations that are still present, possibly causing cut marks on the bones. Certain bones might then be collected and curated for further secondary processing elsewhere while some remain in the original location of the body. These remaining bones could then be subjected to further animal gnawing, weathering or trampling before being incorporated into the midden matrix.

Such a set of burial treatments and non-human taphonomic processes could have a major effect on the bone assemblage. There would be bone loss, possible gnawing, weathering, cut marks and breakage, all of which could occur on different parts of the skeleton. Therefore, the application of the potential skeletal profiles in this study is only considered after detailed examination of the bone has been conducted to assess for the presence of taphonomic indicators on the bone. Of course the absence of taphonomic indicators does not conclusively prove that these processes did not take place on the bones but by applying the knowledge about which parts of the skeleton are likely to be affected and proactively looking for them means that a more robust conclusion about the possibility of taphonomic processes affecting the bones can be drawn than is usually the case. In most skeletal reports published about disarticulated human remains there is no direct mention of taphonomic evidence e.g. in the published reports of human remains for An Corran (Bruce and Kerr 2012; Saville et al. 2012) and the human bone report from Carding Mill Bay no taphonomic evidence is discussed (Lorimer 1991) despite the latter site report raising the possibility that carnivore activity had been present in the fissure context (Connock et al. 1992, 28). This forces the assumption that it has not been considered.

Given that the potential profiles presented in this study therefore represent a simplified version of a single taphonomic process, the approach adopted in this thesis does not rely on the application of these profiles alone. Instead it uses primary examination of the bones to identify any existing traces of modifications, either human or non-human, combined with knowledge of the stratigraphical contexts and spatial data where applicable to inform the possible processes which might have led to the incorporation of the human remains into the midden.

The case study which best demonstrates the potential for this new multi-faceted approach to studying disarticulated remains in shell midden is Havnø. Here it was possible to apply a number of techniques to the bones in order to build up a detailed understanding of the remains. At Havnø traditional osteological recording enabled a starting point for discussing the human remains in the midden but it was the detailed spatial location data provided by the considered and thorough excavation of the midden which enabled so much more detailed information to be drawn out. The spatial data highlighted that there seemed to be a main cluster of bones in one part of the midden and further, more scattered, bones to the north and east of this main cluster. It looked as though the skeletal elements and individuals contained within these groups were distinct phases of burial and that some skeletal selection had occurred due to the lack of ribs and vertebrae from the assemblage.

Study of the Havnø assemblage demonstrates the positive effect that permission to apply a series of destructive analyses to the remains can yield. ZooMS analysis has suggested that the absence of ribs and vertebrae is likely to be due to a real omission from the midden rather than excavation and identification bias, further supporting the interpretation that the skeletal elements which were incorporated into the midden were intentionally selected. Additionally, when the dietary isotope analysis and radiocarbon dating results were also considered, the MNI whose remains had become incorporated into the midden became clearer, being refined from three to five individuals. The phases of use of the midden for burial activity were also clarified using the isotope and radiocarbon data, suggesting that the main bone group represented the first phase of burial just before the end of the Mesolithic with a further inclusion of a juvenile cranial fragment at the beginning of the Neolithic. There were then two further phases of use in the late 3rd millennium BC and the mid 3rd millennium BC of a juvenile and adult, respectively.

Based on this additional knowledge provided by the scientific analyses, the skeletal element analysis conducted on the Havnø human remains could be considered with more certainty. Such certainty about the relationship between remains on the midden is often not possible due to the lack of radiocarbon dates and isotopes which are taken from these types of assemblages. For example, despite Cnoc Coig being one of the most prominently studied disarticulated human remains assemblages from a shell midden (Meiklejohn and Denston 1987; Meiklejohn et al. 2005; Milner and Craig 2009; Nolan 1986; Schulting and Richards 2002) the three dates taken on the human remains come from groups 2 and 3, with none being taken on any of the bones from the minor bone groups and isolated bone. This makes it impossible to draw firm conclusions about the relationship between the main bone group and other remains which are found in the midden, and whether they are likely to be part of one burial process enacted at the site or several phases of burial activity and possible distinct processes.

It is not economical, or often possible, to radiocarbon date or take samples for isotope testing from high numbers of human remains at a site but the study of Havnø has demonstrated that a representative sample of the remains should be considered so that a more conclusive understanding of the burial processes active at the site can be gained.

Further to the fine-grained approach adopted at Havnø it was also possible to apply a newly developed analysis looking at bone diagenesis to the remains in order to postulate whether the bones might have been subject to excarnation processes or burial. This has posed further questions about the remains by suggesting that there is evidence of both practices at the site, possibly on a single body, but shows the added value to being able to tell a story about the history of the remains, rather than simply saying that they are disarticulated and possibly the result of a disturbed burial as is so often the case.

In sum, Havnø offered the opportunity to combine a series of traditional osteological and spatial analyses with new applications of scientific analyses like isotopes, ZooMS and bone diagenesis, from a representative cross section of the human remains in all areas of the midden. This multi-faceted approach and the conclusions that can therefore be drawn about the use of the site as a burial place, demonstrates the importance of studying disarticulated remains in shell middens and doing so in as much depth as possible.

Even where such fine grained spatial data is not present, and the radiocarbon dating and isotope analysis is limited to only two or three bones, this study has shown that by careful examination for taphonomic indicators and comparison to know taphonomic models, a potential scenario for the human and/or non-human involvement with the skeleton can be drawn. Whilst there will inevitably be generalisations applied to these conclusions, there is the potential to say so much more about the reasons why disarticulated human bones became incorporated into shell middens.

8.3 Advancing the understanding of early Neolithic funerary practices

The analysis and interpretation of the four case study sites have shown that it is possible to examine fragmentary and disarticulated remains from shell middens in order to say a lot more about the potential processes which caused them to be deposited in the midden than has usually been the case. It is perhaps a result of their placement into a site type which is predominantly seen as an occupational site focused on refuse, combined with their disarticulated and therefore less obviously "ritual" treatment, which has caused these types of human remains to be somewhat overlooked.

The Scottish case studies provide an opportunity to examine the intrusive placement of Neolithic burials into Mesolithic shell middens and to assess why these sites might be in use for burial in the Neolithic. The transition to agriculture is often presented as a sharp shift (Richards et al. 2003) from the hunter-gatherer lifestyles of the Mesolithic particularly in terms of diet, which are often thought to change from largely marine based diets in the Mesolithic to terrestrial diets in the Neolithic (Richards and Hedges 1999a; Richards and Hedges 1999b; Richards et al. 2003; Schulting and Richards 2002; Schulting and Richards 2001), although this assertion has been questioned due to small sample sizes and problems with the interpretation of isotope data (Milner et al. 2004). Along with a change in diet at the beginning of the Neolithic, there was a view that the onset of the Neolithic was characterised by a "package" of innovations occurring including the introduction of pottery, cultigens and domesticates (Zvelebil 1989) but came to also encompass the production of polished stone tools, monuments and distinctive burial practices (Hellewell and Milner 2011, 61).

Burial practices in the early Neolithic have often been seen as yet another part of the ideological shift that occurred with the onset of agriculture and the apparent introduction of secondary funerary rites and the incorporation of disarticulated remains into monumental structures as acts of ancestor worship (Parker-Pearson 1999; Parker-Pearson 2000; Parker-Pearson 2005; Whitley 2002). It is now being recognised that the assumption that human remains within Mesolithic shell middens, like those in Scotland, were also Mesolithic in date is false (Milner and Craig 2009) and that actually the human remains being placed on these middens are later, often early Neolithic, in date (Wickham-Jones 2009, 482) and the findings of this thesis support the case for intentional placement of Neolithic remains into Mesolithic middens.

The consideration of disarticulated remains in Neolithic studies has been widespread and it is generally accepted that these specimens represent the results of intentional human processing of the remains, with certain elements being selected and removed from the assemblages, for example the proliferation of skulls at Windmill Hill and their under-representation at West Kennet (Parker-Pearson 1999, 52).

Neolithic monumental structures like long barrows and causewayed enclosures are seen as evidence of places of ritual significance particularly where settlement evidence is lacking (Bradley 1998, 37). The amount of time and social organisation required to build such monuments was seen as a means of converting people to the Neolithic way of life (Sherrat 1995, 245). Additionally, the similarities between the domestic structures on the continent to these ritual monuments was highlighted and they were interpreted as liminal places between the domestic and the wild (Hodder 1990) where the significance of the communal labour and the scale of the monument reflected the importance to society. The placement of disarticulated human remains within these structures was therefore naturally interpreted in Neolithic studies as being ritually important (Bradley 1998, 42) and the fact that the remains were not articulated inhumations was not a barrier to interpretation in the same way that it has been in shell midden studies.

There is no doubt that the transition to agriculture signified a massive change in subsistence and the lifeways of the generations of people living in the beginning of the 4th millennium BC, but the scale of the change on a human level, and the speed in which it occurred are now being challenged with the introduction of the Neolithic package being seen as more gradual and sporadic. For example, with the changes being approached from the perspective of human time frames (Cooney 2007) and the refinement of Bayesian frameworks applied to radiocarbon calibration providing a much more fine-grained chronology for the introduction of monuments (Bayliss et al. 2007; Whittle et al. 2007a).

Further, a number of recent studies have shown that burial practices involving disarticulated remains, which have traditionally been seen as Neolithic innovation, are also evidenced in the Mesolithic (Conneller 2006; Gray Jones 2011). These Mesolithic remains have often been overlooked because of their non-monumental placement within the landscape. In Britain there is evidence that caves represent a common burial loci in both the Mesolithic and Neolithic (Hellewell and Milner 2011) rather than the use of caves being a Neolithic innovation as previously suggested (Chamberlain 2001). The use of early Neolithic long barrows as places of the dead are seen as a means of routing the dead in a monument whose structure is based on settlement structures used by previous generations (Bradley 1998; Hodder 1990). As such, the concept of continuity and recognising what has gone before is demonstrated in early Neolithic burial practices.

Therefore, the use of Mesolithic shell middens in which to place early Neolithic human remains, as identified in the Scottish case studies here, can be seen as a process not dissimilar to the incorporation of Neolithic burial remains into monumental structures. Additionally, there have been some suggestions that shell middens might themselves represent monumental places on the landscape (Sherrat 1995), or liminal places between land and sea (Pollard 1996), which would again make the incorporation of human remains within them similar to the concept of placing human remains within early Neolithic long barrows. Likewise, the placement of some chambered tombs in Scotland on top of earlier shell middens and raised beaches is seen as a means of signifying the importance of these places in the landscape (Pollard 1996, 205).

The perception of the burial rites enacted at the beginning of the Neolithic is changing and further study like the research presented here can continue to advance our understanding that there might have been intentional continuity in the early Neolithic between a known ancestor and an old, or changed, Mesolithic way of life. If the human experience of the transition to agriculture is considered, then the possibility that there is continuity of practices, particularly involving the treatment of the dead seems likely. Although, whether the Neolithic populations in Britain were incoming farmers from the continent, indigenous hunter-gatherers who changed their way of life, or a combination of the two is still not clear. New DNA studies (Malmström et al. 2009) have the potential to shed light on the origins of these populations. If this uncertainty can be clarified then the interpretation and understanding of the degrees of change and continuity around the time of the transition might be easier to achieve.

Although the continued use of the Havnø midden for burial across the Mesolithic/Neolithic transition would appear to support the interpretation of the Scottish middens as demonstrating continuation in burial practices at this time, when the funerary processes present at Havnø are considered, a different picture emerges. The late Mesolithic burial appears to be a single adult individual who was subjected to complex funerary treatment involving defleshing and some degree of burial before being brought to the midden and incorporated into the shell matrix. Early in the Neolithic period a single fragment of Juvenile skull which appears to have been excarnated was incorporated into the midden. Later, further excarnated remains were also deposited at the midden. What appears to be happening here is that the site is used for funerary depositions both before and after the transition to agriculture but with very different burial practices being undertaken. The use of the site across the transition appears to demonstrate continuity but the practices employed suggest that the possible motives for placing human remains into the Havnø midden might have less to do with retaining links with ancestors and more to do with the perception of the midden at the time in question.

Chapter Nine: Conclusion

9.1 Disarticulated remains in middens are more than disturbed burials

The research presented as part of this study highlights the significant role that disarticulated remains in shell middens can play in understanding burial practices around the time of the Mesolithic/Neolithic transition. Consideration of these often overlooked remains using a range of traditional osteological techniques combined with more cutting edge scientific methods makes it clear that these bones are likely to have resulted from more complex funerary processes than simply disturbed inhumation burials.

By understanding the non-human taphonomic processes affecting disarticulation of bodies and the range of human funerary actions which can lead to disarticulation, it has been shown that often the assemblages of human remains appear to have been manipulated and certain bones selected for secondary treatment. Explicit examination of the skeletal elements present in an assemblage is often not included where disarticulated remains are considered but the presence or absence of certain elements is all important in assessing the taphonomic processes leading to their deposition. This study has shown that by presenting and analysing these skeletal element profiles, possible causes for the disarticulation can be determined. Additionally, where specific spatial locations for human bones are available, the distribution of the specimens across the midden can reveal a lot about the possible causes of deposition. This is most clearly the case at Havnø where the spatial data was recorded and has been made available and thus it has been possible to plot the location of every human bone identified. This revealed a distinct bone group and subsequent minor groups which appear to relate to distinct phases of use within the midden.

The analysis conducted on the case study assemblages from Scotland involved re-examination of the human skeletal remains in order to specifically look for evidence of taphonomic indicators on the bone. This was necessary because the presence or absence of cutmarks, weathering, animal gnawing and other taphonomic alterations is not something which is widely reported in human bone reports, despite being commonplace in assessments of faunal assemblages. Additionally, it is often difficult to ascertain which skeletal elements were actually present in a disarticulated assemblage, as the published material does not include that level of detail. Therefore, by conducting primary analysis on archived human bone collections it has been demonstrated that a much finer degree of detail about the remains, their skeletal element profiles and existence of taphonomic indicators can be achieved. All of these details are necessary when considering the possible funerary or non-human taphonomic factors which resulted in the deposition of disarticulated human remains into shell middens.

Another important factor in advancing the understanding of disarticulated human remains in shell middens has been the in-depth consideration of the archival contextual information relating to the assemblages. In this study, detailed review of the existing contextual information available in the site reports and archives has provided a deeper understanding of how the various commingled human remains within the case study sites relate to each other. Simply by reviewing existing contextual information, a better understanding of the minimum number of individuals and the possible links between contexts can be achieved. Modern excavation techniques and equipment like total-station theodolites should, in the future, allow the excavation of shell midden sites to gather much higher resolution spatial data.

9.2 A model for future research

The research conducted on the human remains assemblage from Havnø shell midden provides the best example of what can be achieved from disarticulated remains given the right research design. This case study can be considered a model for future research into disarticulated human remains in shell middens, and perhaps even other types of site.

In future shell midden excavations the best possible analysis of the human remains would be achieved if every find (artefacts, bone – human and animal) was recorded in three-dimensions using a total-station theodolite. This would allow the exact locations of the human remains to be plotted within the midden, and crucially, compared to other find types within the site. It has not been possible to address the relationship between the human remains and faunal assemblage at Havnø as part of this study, but such a comparison could yield important information about the similarities or differences in deposition between human and animal remains. There is also the possibility that there are direct depositional relationships between human and animal remains, like the extremities and seal flipper at Cnoc Coig, which could be identified using three dimensional data. Additionally it would aid interpretation if the human remains were also photographed *in situ* where possible in order for any potential anatomical positioning to be identified.

Post-excavation analysis of the human remains should employ a methodology based on the one developed for this study where the traditional osteological identification of elements is established along with recording of ageing, sexing and any pathology present. Additionally, there should be direct analysis and consideration of the existence of taphonomic alterations to the bone. Specifically cutmarks, gnaw marks, weathering, burning, peri-mortem breakage and root or fungal activity should be noted. The absence of these markers is of equal importance in the reporting of the human remains in order for it to be clear that these have been considered but not identified.

Following the macro analysis of the bones and the plotting of their spatial location in the midden further analysis can then be conducted to establish the likely MNI and the phases in which the specimens were incorporated into the midden. It is important to note here that spatial and osteological analysis should be combined to try to identify as many potential individuals within the assemblage as possible and a representative sample should then be taken in order to achieve full understanding of the processes at play on the midden. Often the major groups of bones are the only ones to be sampled for dating and dietary isotope programmes, as at Cnoc Coig where none of the minor groups have been dated and at Carding Mill Bay where there are no dates taken from the unstratified midden or later shell midden. By omitting some contexts from dating and isotope analysis, a full picture of the site cannot be developed because their potential contemporaneity and relationship to the other bones is not established. However, by ensuring that bones from all areas of the midden, and representing as many individuals as possible, are sampled a clearer picture of the relationships between the commingled bones can be established. This was the case at Havnø where dietary isotope analysis helped to refine minimum number of individuals and the radiocarbon dates showed that the individuals are likely to have been part of distinct burial phases.

Further understanding of the assemblages can also be achieved by the implementation of processes such as ZooMS and bone diagenesis analyses. The identification using ZooMS of smaller and more fragmentary bones as human specimens could aid understanding of the fragmentation patterns of the bones, and their similarity, or not, to animal bones at the site. For example, human bones might be just as fragmentary as animal bone which could signify a similarity in treatment of the bones, whereas a different degree of fragmentation might imply that these bone types were treated differently.

Bone diagenesis analysis can help to ascertain whether the bones were subject to fast skeletonisation relating to excarnation or defleshing practices or slower degradation akin to inhumed remains. This has the potential to advance the understanding of burial practices at shell midden sites, and elsewhere, and should be considered for a representative sample of the human remains from shell midden sites.

As well as applying osteological and scientific techniques to the human remains, the actual assemblage as a whole should be considered. The presentation of skeletal element diagrams in this study has shown that by understanding what elements make up an assemblage, the possible human or non-human taphonomic processes leading to these groups of bones can be assessed. If a detailed skeletal element catalogue is provided in future studies of disarticulated remains, then it will be possible to assess the taphonomic processes leading to the incorporation of the remains into shell middens. The potential skeletal profiles established for this study should be used as comparisons and a starting point in order to further examine the evidence for these taphonomic processes having had an effect on the human remains.

9.3 Future research questions

Whilst this study has demonstrated the potential for studying disarticulated human remains in shell middens, there remain avenues for future research which were not possible to pursue under the remit of this study. It is hoped that this study has served to establish the importance of these types of remains in the discourse surrounding shell middens as well as into the wider discussions of burial practices in the Mesolithic/Neolithic transition. However, similarities between the human and animal remains at these sites could enhance our understanding of the relationships between human and animals at a time of changing perceptions of the wild and domestic which came with the introduction of agriculture.

The re-examination of existing shell midden sites and wide-scale dating of the disarticulated human remains could refine our understanding of the transition from Mesolithic to Neolithic with the potential to identify new sites where bones were placed into ancient contexts. It appears that the incorporation of disarticulated remains into shell middens after 4,000 BC is a new development of burial practices at this time but further comparison of the skeletal element profiles from both late Mesolithic burial contexts as well as early Neolithic monuments would allow assessment of whether the shell middens represented a continuation of old practices or part of an entirely new development in treatment of the dead.

The relationship between the shells, feasting and ancestors, which has been identified in North American shell midden studies (Claassen 2013; Luby and Gruber 1999), might also be evident in the European evidence, as is suggested at Téviec and Hoëdic (Schulting 1996). Further contextual analysis of the shell middens and evidence for hearths, burning and feasting in close proximity to the human remains might make conclusions of this nature possible.

Further understanding of the nature of disturbed inhumation burials in shell middens would be possible through the analysis of the skeletal element profiles in a shell midden containing both inhumation burials which are still in articulation as well as disarticulated remains, such as one of the Brazilian sambaquis (Wagner et al. 2011). This type of study would allow direct comparison between the remains from both types of burials and would extend the type of comparative analysis which was presented in the Carding Mill Bay case study in this research.

9.4 Conclusion

Overall, the aim of this study was to establish whether the disarticulated human remains in shell middens are likely to be a product of disturbed inhumation burials or not. What has been demonstrated here is that there are a variety of possible explanations for disarticulated bones in middens, one of which is that inhumation burials have become disturbed or poorly preserved. There are however many more, and arguably more likely, explanations for the incorporation of disarticulated human remains into shell middens such as; excarnation, residual incorporation after collection of main skeletal elements, and intentional placement as part of secondary burial practices. Due to the large number of possible processes which could have led to the incorporation of disarticulated remains into shell middens it might never be possible to ascertain exactly which process was at play. In fact, it is likely that at most sites there was a combination of human and non-human taphonomic processes at work. However, it is clear that to simply refer to these types of remains as disturbed burials oversimplifies the evidence and actually gives a false impression of the approach to funerary practices that people employed at the time of the transition to agriculture.

Appendix 1

Appendix 1.1 Disarticulated remains recording sheet

E Hellewell — Placement of Human Remains in Shell Middens

Disarticulated and Commingled Bone Recording Sheet **Page 1**

Site Name:	Site Code:	Unit:	Area/ Trench:	Context No:	Feature No:	Skeleton No:

Place of Curation of Remains:	
Analysed by:	Analysis Date:

Bone Summary

Bone:	Side:	Segment:	Complete? Portion:	Preservation:

Associated skeletons/ bones/ burials based on site records:	
Position in midden:	Orientation of bone:
Number of fragments:	
Fragment size*: (Max length and max width)*	
Associated bones based on refitting:	
Additional notes:	
Age:	Sex:
Stature:	
Photos:	

Taphonomy:

Burning[+]:	Colour:	% affected:	Surface texture:	Warped? (y/n)	Comments; # of photos; # of drawings:

Weathering:	Location:	^Degree:	Description:	Comments; # of photos; # of drawings:

~ Cutmarks:	Location:	No. of Cuts:	Range and average of cut lengths:	Description; # of photos; # of drawings:

^ Weathering stages (Buikstra and Ubelaker 1994, 98). ~ Chop, cut, light defleshing mark (McKinley 2004, 15).
Y Fractures: fresh/ old; sharp sided/ clean edged; spiral fracture; rounded (McKinley 2004, 15).
+ Burning (Lyman 1994; B. and U. 1994)

Disarticulated and Commingled Bone Recording Sheet

Page 2

Taphonomy:

Gnawing:	Location:	No. of paired grooves/ incisions:	Description:	# of photos; # of drawings:

Root/ fungal activity:	Location:	Description:	# of photos; # of drawings:

ᵞ Peri-mortem breakage:	Location:	Description:	No. of fragments:	Comments; # of photos; # of drawings:

Other cultural modifications:	Location:	Description:	Comments; # of photos; # of drawings:

Pathology:

Description:	# of photos; # of drawings:

Ostoelogical Measurements:

Non metric traits and other observations:

^ Weathering stages (Buikstra and Ubelaker 1994, 98). ~ Chop, cut, light defleshing mark (McKinley 2004, 15).
ᵞ Fractures: fresh/ old; sharp sided/ clean edged; spiral fracture; rounded (McKinley 2004, 15). + Burning (Lyman 1994; B. and U. 1994)

Appendix 2

Appendix 2.1 Catalogue of human remains from Janaba JE0004

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 817-a	Adult	Lower limbs	Leg	Femur	left	Head has fused to the neck therefore probably an adult individual.	FALSE	Femoral hear and part of neck	1	Fragmentary	Poor
15FA, 854-1	Adult	Extremities	Hand	Metacarpal, 4	left	Presumably based on fusion of proximal epiphysis	FALSE	Proximal 1/4	1	Fragmentary	Poor
15FA, 860-a	Adult	Extremities		Phalanx		Based on total fusion of bone	TRUE		1	Complete	Poor
15FA, 863	Adult	Lower limbs	Leg	Fibula	unknown	Based on fusion of proximal epiphysis	FALSE	Proximal end and shaft fragments	7	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FC, 870	Adult	Lower limbs	Leg	Patella	left	Seems to be full size	FALSE	missing some of posterior surface and medial anterior edge	1	80%	Fair
In situ, F09_In situ-a	Adult	Lower limbs	Leg	Femur, distal end; Tibia, proximal end	Left?		FALSE	Distal end of femur and proximal end of tibia, glued together	2	Fragmentary	Poor
In situ, F09_In situ-b	Adult	Lower limbs	Leg	Fibula	Right		FALSE	Distal end and some shaft fragments	4	Fragmentary	Poor
15FA, 1266-a	Unknown	Extremities	Foot	Phalanx, proximal	Unknown		FALSE	proximal 1/2 missing head.	1	Fragmentary	Poor
15FA, 1266-b	Unknown	Extremities	Foot	Metatarsal	Unknown		FALSE	Fragment of base	1	Fragmentary	Poor
15FA, 1270-a	Unknown	Extremities	Foot	Phalanx, proximal	Unknown		FALSE	missing part of distal epiphysis	1	90%	Poor
15FA, 1270-b	Unknown	Extremities	Foot	Phalanx	Unknown		FALSE	shaft and part of tip, missing proximal epiphysis and most of head	1	70%	Poor
15FA, 1270-c	Unknown	Extremities	Foot	Metatarsal	Unknown		FALSE	Head and small part of shaft	1	Fragmentary	Poor
15FA, 1270-d	Unknown	Extremities	Foot	Metatarsal	Unknown		FALSE	part of head and small part of shaft.	1	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
15FA, 1270-e	Unknown	Extremities	Foot	Metatarsal	Unknown		FALSE	Head	1	Fragmentary	Poor
15FA, 1271	Unknown	Extremities	Foot	Phalanx, 1st Proximal	Unknown		FALSE	Part of base, some of head and 2 shaft fragments	4	Fragmentary	Poor
15FA, 1272-a	Unknown	Extremities	Foot	Metatarsal, 5?	Unknown		FALSE	Proximal 1/2 but with part of base missing	1	70%	Poor
15FA, 1272-b	Unknown	Extremities	Foot	Phalanx, 5th? Proximal	Unknown		FALSE	Missing tiny fragments of base and head but largely complete		98%	Poor
15FA, 1272-c	Unknown	Extremities	Foot	Metatarsal	Unknown		FALSE	Fragment of base and some of shaft	1	Fragmentary	Poor
15FA, 1272-d	Unknown	Extremities	Foot	Metatarsal, fragment	Unknown		FALSE	Very fragmentary and difficult to identify due to weathering, but some shaft and head present.	9	Fragmentary	Poor
13FC, 837-a	Unknown	Extremities	Hand	Metacarpal?		Juvenile? Based on size.	FALSE	shaft and head	1	70%	Poor
15FA, 847-a	Unknown	Extremities	Foot	Talus	Left?		FALSE	Part of trochlea and head and some of calcaneal surface	1	Fragmentary c. 60%	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
15FA, 847-b	Unknown	Extremities	Foot	Navicular	left?		FALSE	missing tubercule	1	90%	Poor
15FA, 847-c	Unknown	Extremities	Foot	Cuboid?	Unknown		FALSE		1	Fragmentary	Poor
15FA, 847-d	Unknown	Extremities	Foot	Intermediate cuneiform	Right?		FALSE	Missing some of dorsal surface and navicular articular surface	1	90%	Poor
15FA, 847-e	Unknown	Extremities	Foot	Unidentified tarsals	Unknown		FALSE	2 fragmentary tarsals fused together	1	Fragmentary	Poor
15FA, 847-f	Unknown	Extremities	Foot	Phalanx, proximal	Unknown		FALSE	Proximal epiphysis only	1	Fragmentary	Poor
15FA, 854-b	Unknown	Extremities	Hand	Metacarpal, 3?	Unknown	Based on fact that epiphysis is missing, but probably adult	FALSE	Proximal 1/3 missing part of epiphysis	1	Fragmentary	Poor
15FA, 854-c	Unknown	Extremities	Hand	Phalanx	Unknown		FALSE	Base and part of shaft missing	1	Fragmentary	Poor
15FA, 855-a	Unknown	Extremities	Hand	Trapezium?	Unknown		FALSE		1	80%	Poor
15FA,855-b	Unknown	Extremities	Hand	Scaphoid?	Unknown		FALSE	missing tubercule	1	50%	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
15FA, 855-c	Unknown	Extremities	Hand	Pisiform?	Unknown		FALSE		1	75%	Poor
15FA, 855-d	Unknown	Extremities	Hand	Unidentified carpals	Unknown		FALSE	fragmentary	3	Fragmentary	Poor
15FA, 857-a	Unknown	Extremities	Foot	Phalanx, proximal 1st			FALSE	Missing distal head and part of shaft	1	Fragmentary	Poor
15FA, 857-b	Unknown	Extremities	Foot	Phalanx, intermediate	Unknown		FALSE	Base	1	Fragmentary	Poor
15FA, 857-c	Unknown	Extremities	Foot	Phalanx, intermediate 4?	Unknown		FALSE	Some head missing	1	90%	Poor
15FA, 857-d	Unknown	Extremities	Foot	Phalanx, intermediate 5?	Unknown		FALSE	Missing part of base and head	1	90%	Poor
15FA, 860-b	Unknown	Extremities	Hand	Metacarpal	Unknown		FALSE	Fragments of head and base, also some shaft fragments	17	Fragmentary	Poor
15FA, 861-a	Unknown	Extremities	Hand	Phalanx	Unknown		FALSE	Missing distal tip	1	75%	Poor
15FA, 861-b	Unknown	Extremities	Hand	Metacarpal fragments	Unknown		FALSE	part of head and shaft and one piece of proximal base	9	Fragmentary	Poor
15FA, 867	Unknown	Extremities	Hand	Phalanx	Unknown		FALSE	Fragment of shaft and head	24	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FC, 956-1	Unknown	Extremities	Hand	Phalanx			FALSE	proximal?	1	60%	Poor
14FC, 956-b	Unknown	Extremities	Hand	Phalanx, medial			FALSE	missing part of proximal base	1	80%	Poor
14FC, 956-c	Unknown	Extremities	Hand	Phalanx, distal?			FALSE	half of head and shaft	1	50%	Poor
14FA, 817-e	Unknown	Limb		Long bone? Fragment			FALSE	Unidentified fragment ?long bone	1	Fragmentary	Poor
15FA, 859	Unknown	Limb		Long bone fragment			FALSE		1	Fragmentary	Poor
15FA, 1269	Unknown	Lower limbs	Leg	Tibia?	Right?		FALSE	Distal end plus fragments	6	Fragmentary	Poor
15FA, 858	Unknown	Lower limbs	Leg	Fibula?	Unknown		FALSE	Shaft fragments	15	Fragmentary	Poor
14FC, 862-a	Unknown	Lower limbs	Leg	Fibula?			FALSE	Shaft fragments	26	Fragmentary	Poor
15FA, 864-a	Unknown	Lower limbs	Leg	Tibia?	Unknown		FALSE	Proximal articular facet but very weathered so difficult to determine with accuracy	1	Fragmentary	Poor
15FA, 864-b	Unknown	Lower limbs	Leg	Unidentified fragments of long bone	Unknown		FALSE	unidentified fragments due to severe weathering	6	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
15FA, 864-c	Unknown	Lower limbs	Leg	Unidentified long bone	Unknown		FALSE	unidentified long bone fragments	10	Fragmentary	Poor
865-a	Unknown	Lower limbs		Tibia?			FALSE	Epiphysis?		Fragmentary	Poor
15FA, 865B	Unknown	Lower limbs	Leg	Femur?	Unknown		FALSE	Fragments of shaft, some possible femoral head	13	Fragmentary	Poor
In situ, F09_In situ-c	Unknown	Lower limbs	Leg	Tibia	Unknown		FALSE	shaft fragments	61	fragmentary	Poor
14FA, 816-a	Juvenile	Extremities		Phalanx?		? Looks as if epiphysis is unfused	FALSE	Epiphysis-unfused?	1	Fragmentary	Poor
14FA, 817-c	Juvenile	Extremities	Hand	Metacarpal 1		base has not fused but is missing	FALSE		1	90% missing some of distal surface	Fair
14FA, 817-d	Juvenile	Extremities		Phalanx		Slender and base looks unfused.	TRUE		1		Fair
13FC, 837-c	Juvenile	Extremities		Phalanx		?juvenile based on size and non-fused epiphysis	FALSE	base	1	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 839-a4	Juvenile	Limb		Unfused long bone epiphysis		unfused epiphysis but fragmentary so can't tell which long bone	FALSE	unfused long bone epiphysis	1	Fragmentary	Poor
813-b	Juvenile	Lower limbs		Long bone (?tibia) and unfused epiphysis?		Based on non-fusion of shaft and epiphysis	FALSE	?Tibia unfused epiphysis and shaft	2	Fragmentary	
14FA, 815-b	Juvenile	Rib cage	Rib	Rib			FALSE	Part of rib shaft	1	Fragmentary	Poor
14FA, 825-a	Juvenile	Rib cage	Rib	Rib fragments			FALSE	head and shaft	2	Fragmentary	Poor
14FA, 834-g2	Juvenile	Rib cage	Rib	Rib fragments		Possibly non adult as very small	FALSE	part of head and neck	1	Fragmentary	Poor
14FA, 835	Juvenile	Rib cage	Rib	Rib fragments			FALSE		14	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 836-c	Juvenile	Rib cage	Rib	Rib		?juvenile based on size of first rib being small	FALSE	1st rib and other rib fragments	3	fragmentary	Poor
14FA, 815-a	Juvenile	Skull	Tooth	Deciduous molar 1, lower?	Right	No visible root reabsorption and tooth fully erupted so probably 4 years +/- 12 mo.s	FALSE	Tooth and part of buccal mandible	1	Tooth complete but jaw fragmentary	Poor
14FA, 839-b1	Juvenile	Skull	Tooth	Mandible	Right	Based on size	FALSE	Mandibular condyle and coronoid process plus part of mandibluar foramen and an unidentified fragment of mandible	3	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 846a	Juvenile	Skull	Tooth	Mandible and teeth	Left	C. 6 years Fits most with the 6 years +/- 24 months diagram. M2 is present in mandible and both M1 and M2 can be removed to see root development	FALSE	Left mandible; dm1, dm2, M1 and M2 present in mandible	3	fragmentary	Poor
14FA, 846c	Juvenile	Skull	Tooth	lower M1?	Right?	Based on root developme nt and comparison to 846a c. 6 years +/- 24 mos .	FALSE	Tooth only. Crown but root not yet developed	1	Complete	Poor
14FA, 846d	Juvenile	Skull	Tooth	lower dm2	Right?	Based on comparison with 846a c. 6 yrs.	TRUE		1	complete	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 846e	Juvenile	Skull	Tooth	Upper I1	Right	Based on root development c. 4+/- 12mos. This is comparable to other 846 specimens which age to 6yrs +/- 24 mos	TRUE		1	complete	Poor
14FA, 846f	Juvenile	Skull	Cranium	Maxilla fragments; Teeth: I2 upper; C1 upper; dm1 upper; PM1 upper; PM2 upper; dm2 upper; M1 upper	Right	Based on tooth and root development 4 yrs +/- 12 mos. Or 5 yrs +/- 15 mos.	FALSE		8	fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 864g	Juvenile	Skull	Tooth	Mandible and teeth	Right	6 yrs +/- 24 mos. Based on comparison with 846a	FALSE	mandible fragment and M1 (lower)	3	fragmentary	Poor
14FA, 846h	Juvenile	Skull	Cranium	Cranial fragments, parietal	Unknown	based on thickness and association with other 846 contexts	FALSE	fragments of parietal	3	fragmentary	Fair
14FA, 940-c: pit fill	Juvenile	Skull	Tooth	Lower deciduous incisor 2	Left?	4 years +/- 12 months based	TRUE			Complete	Poor
14FA, 836-b	Juvenile	Vertebral column	Spine	Vertebral bodies and arches		Bodies and arches unfused- juvenile, aged 4-7 yrs based on fusion of arches but not arches to body	FALSE	Bodies and arches of cervical? And thoracic?	8	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 839-a2	Juvenile	Vertebral column	Spine	Axis		Superior surface of the odontoid process is ridged similar to that of a 6 yr old. Looks as if the arch has fused to the body- 2 and 7 years.	FALSE	Arch fragment	1	Fragmentary	Poor
14FA, 815-c	Juvenile?	Skull	Cranium	Cranial fragments			FALSE	Cranial fragments	3	Fragmentary	Poor
14FA, 833-a	Juvenile?	Skull	Cranium	Cranial fragments			FALSE	Cranial fragments	7	Fragmentary	Poor
14FA, 834-a	Juvenile?	Skull	Cranium	Cranial fragments, ?temporal ?human			FALSE	?Human temporal fragment	1	Fragmentary	Poor
14FA, 834-b	Juvenile?	Skull	Cranium	Cranial fragments			FALSE	Cranial fragment	1	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 834-c	Juvenile?	Skull	Cranium	Cranial fragments			FALSE	Cranial fragment	1	Fragmentary	Poor
14FA, 836-a	Juvenile?	Skull	Cranium	Cranial fragments, ?temporal			FALSE	?Temporal fragment	1	Fragmentary	Poor
14FA, 839-a1	Juvenile?	Skull	Cranium	Cranial fragments, ?Frontal		Non adult because very thin?	FALSE	Frontal cranial fragments	2	Fragmentary	Poor
14FA, 839-b2	Juvenile?	Skull	Cranium	Cranial fragments			FALSE	Cranial fragments	14	Fragmentary	Poor
14FA, 839-c	Juvenile?	Skull	Cranium	Cranial fragments			FALSE	?Temporal	10	Fragmentary	Poor
14FA, 839-d	Juvenile?	Skull	Cranium	?cranium			FALSE	cranial fragments?	2	fragmentary	Poor
14FA, 846b	Juvenile?	Skull	Cranium	Cranial fragments			FALSE	cranial fragmemts	7	very fragmentary	Poor
14FA, 846i	Juvenile?	Skull	Cranium	Cranial fragments, parietal?	Unknown	juvenile based on thickness and association with other 846 contexts	FALSE	parietal fragments	21	fragmentary	Fair

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 846i	Juvenile?	Skull	Cranium	Cranial fragments, temporal	Right	based on association with other 846 contexts then prob. Juvenile	FALSE		6	Fragmentary	Fair
14FA, 846m	Juvenile?	Skull	Cranium	Cranial fragments, ?maxillae	Unknown	based on association with other 846 contexts could be juvenile	FALSE	very fragmentary	17	fragmentary	Poor
14FA, 834-d	Juvenile?	Vertebral column	Spine	Vertebral arch fragments		Feels quite small but could be an adult vertebra based on comparison in size	FALSE	Arch of thoracic vertebra	1	Fragmentary	Poor
14FA, 834-e	Juvenile?	Vertebral column	Spine	Vertebral arch fragments			FALSE	Half of arch including an articular facet	1	Fragmentary	Poor

Context Number, Skeleton Number	Age	Part of Body 1	Part of Body 2	Bone	Side	Age Notes	Bone Complete?	Portion	Number of Fragments	Completeness	Preservation
14FA, 834-g3	Juvenile?	Vertebral column	Spine	Vertebral arch fragments			FALSE	Vertebral arch fragments	5	Fragmentary	Poor
14FA, 839-a3	Juvenile?	Vertebral column	Spine	Vertebral arch fragments			FALSE	Arches	11	Fragmentary	Poor
14FA, 834-g1	Non-adult	Limb		Unfused epiphysis of a long bone		Unfused epiphysis but incomplete so not sure which long-bone and therefore what size it is	FALSE	Unknown long bone unfused epiphysis	1	Fragmentary	Poor

Appendix 3

A full inventory of human skeletal remains from Carding Mill Bay is found in "Appendix 3.1 Inventory of all human remains at Carding Mill Bay".

During the visit to GMRC all boxes classified as containing "bone" from the shell midden at Carding Mill Bay were made available for study and it was possible to identify some human remains which had not been recorded as human on the GMRC catalogue entries. These specimens are listed in "Appendix 3.2 Newly recognised human remains". It has not been possible to ascertain whether these bones have previously been identified as human and misclassified in the records or if these have been identified for the first time. Some, such as A.1997.10.df was a femur sampled for isotopes by Schulting and Richards (2002) and was obviously recognised as human at this time.

It was not possible to view several bones during the visit to GMRC because they were not available for study at that time. It has been possible to refer to photographs kindly supplied by Jane Flint for several of the missing bones, although some have not been viewed at all. "Appendix 3.3 Specimens not subject to primary analysis" summarises which bones have been viewed only via photographs and which have not been seen at all, as well as providing details of bones which have not been analysed because they were removed from the collection for study by other researchers.

In Lorimer's report (1991) she details specimens from the unspecified midden context XII. Other than this mention of these remains, detailed in "Appendix 3.3 Specimens not subject to primary analysis", there is no other mention of these remains in any of the published material dealing with Carding Mill Bay. These specimens were not present in the GMRC collection viewed as part of this study and at this time the location of these specimens is unclear. They have however, been included in this new skeletal analysis, as Lorimer's report contains general identification of skeletal elements from this context (Lorimer 1991, 4) and the fiche skeletal diagrams and inventory (Connock et al. 1991) further identify the remains. They have therefore been dealt with alongside the specimens from context IV which is also unspecified shell midden. Where skeletal identification can be achieved for missing specimens they have been included in the analysis, and this is indicated in "Appendix 3.3 Specimens not subject to primary analysis". Specimens which are simply listed as "bone" cannot be further identified at this stage and have therefore been excluded from the following analysis.

Appendix 3.1 Inventory of all human remains at Carding Mill Bay

The table below details all identified human skeletal specimens from Carding Mill Bay contexts excluding the Cist burial. An inventory of the cist burial remains is available in Lorimer's fiche (Connock et al. 1991).

Context	Context number	Skeleton number	Part of body 1	Part of body 2	Bone	Notes
Earlier shell midden	VII 112	A1997.10.ad	Extremities	Foot	Metatarsal 3, right	Totally destroyed
Earlier shell midden	VII 121	A1997.10.ae	Extremities	Foot	Metatarsal 4, right	
Earlier shell midden	VII 130	A1997.10.af	Skull	Cranium	Parietal	
Earlier shell midden	VII 130	A1997.10.ga(c)	Skull	Cranium	Parietal	Totally destroyed
Earlier shell midden	VII	Unknown	Extremities	Hand	Metacarpal shaft	Detailed by Lorimer (1991, 3-4) current location unknown
Earlier shell midden	VII	Unknown	Upper limbs	Arm	Ulna shaft	Detailed by Lorimer (1991, 3-4) current location unknown
Earlier shell midden	XIV 1	A1997.10.dm	Extremities	Hand	Proximal phalanx	Totally destroyed
Earlier shell midden	XV 1	A1997.10.dn	Extremities	Hand	Metacarpal shaft	Totally destroyed
Earlier shell midden	XVII 1	A1997.10.dp	Extremities	Hand	Distal phalanx	Totally destroyed
Earlier shell midden	XVII 6	A1997.10.do	Vertebral column	Spine	Thoracic vertebra	
Later shell midden	X 1	A1997.10.ga(d)	Upper Limbs	Shoulder	Scapula, left	Juvenile c. 10-11 yrs Totally destroyed

Context	Context number	Skeleton number	Part of body 1	Part of body 2	Bone	Notes
Later shell midden	X	A1997.10.dh	Skull	Jaw	Mandible and teeth	Juvenile c. 2-3 yrs Seen as part of this study
Later shell midden	X	Unknown	Skull	Teeth	7 Permanent teeth	Juvenile c. 10-11 yrs (Lorimer 1991) Not seen as part of this study
Later shell midden	X	Unknown	Rib cage	Rib	8 Rib shaft fragments	Juvenile (Lorimer 1991) Not seen as part of this study
Later shell midden	X	Unknown	Lower limbs	Pelvis	3 Pelvis fragments	Juvenile (Lorimer 1991) Not seen as part of this study
Later shell midden	X	Unknown	Rib cage	Rib	Rib fragment	Adult (Lorimer 1991) Not seen as part of this study
Fissure	V 105	A1997.10.df	Lower limbs	Leg	Femur, right	Sampled by Schulting and Richards (2002)
Fissure	V 106	A1997.10.da	Lower limbs	Leg	Tibia, left	
Fissure	V 107	A1997.10.db	Lower limbs	Leg	Fibula, right	
Fissure	V 138	A1997.10.dc	Extremities	Foot	Metatarsal 1, right	
Fissure	V 139	A1997.10.dd	Extremities	Foot	Metatarsal 2, right	
Fissure	V 140	A1997.10.de	Vertebral column	Spine	Thoracic vertebra	
Fissure	V 141	A1997.10.dg(a)	Vertebral column	Spine	Vertebra	
Fissure	V 141	A1997.10.dg(b)	Rib cage	Rib	Rib, 2 fragments	

Context	**Context number**	**Skeleton number**	**Part of body 1**	**Part of body 2**	**Bone**	**Notes**
Fissure	XXII 1	A1997.10.ds(b)	Vertebral column	Spine	Cervical vertebra	
Fissure	XXII 1	A1997.10.ds(c)	Vertebral column	Spine	Thoracic vertebra, ?12th	
Fissure	XXII 1	A1997.10.ds(a)	Vertebral column	Spine	Thoracic vertebra	
Fissure	XXIII		Skull	Tooth	upper and lower 1st premolars	(Lorimer 1991) Not seen for this study
Fissure	XXIII	A.1997.10.ew	Extremities	Foot	Metatarsal 1, head, left?	(Lorimer 1991) and seen via photo for this study
Fissure	XXIII		Rib cage	Rib	Rib, 3 fragments	Non-adult (Lorimer 1991) Not seen for this study
Fissure	XXIII	A.1997.10.s	Skull	Jaw	Mandible and teeth	(Lorimer 1991) and seen via photo for this study
Fissure	XXIII	A.1997.10.aa	Vertebral column	Spine	Lumbar vertebra	Non-adult (Lorimer 1991) and seen via photo for this study
Fissure	XXIII		Vertebral column	Spine	atlas	(Lorimer 1991) Not seen for this study
Fissure	XXIII		Vertebral column	Spine	6th cervical vertebra	(Lorimer 1991) Not seen for this study
Fissure	XXIII		Vertebral column	Spine	7th cervical vertebra	(Lorimer 1991) Not seen for this study
Fissure	XXIII		Vertebral column	Spine	1st thoracic vertebra	(Lorimer 1991) Not seen for this study
Fissure	XXIII		Vertebral column	Spine	2ndthoracic vertebra	(Lorimer 1991) Not seen for this study

Context	Context number	Skeleton number	Part of body 1	Part of body 2	Bone	Notes
Fissure	XXIII		Rib cage	Rib	fragments x 5	(Lorimer 1991) Not seen for this study
Fissure	XXIII		Upper limbs	Shoulder	Scapula fragments x3	(Lorimer 1991) Not seen for this study
Fissure	XXIII		Upper limbs	Arm	humerus, right	(Lorimer 1991) Not seen for this study
Fissure	XXIII	A1997.10.ga(e)	Extremities	Foot	Metatarsal 3, left	Totally destroyed
Fissure	XXIV 10	A1997.10.at	Extremities	Hand	Proximal phalanx 3 or 4	
Fissure	XXIV 3	A1997.10.ap	Extremities	Hand	Distal phalanx	
Fissure	XXIV 7		Upper limbs	Shoulder	?corocoid process and 3 fragments of scapula	(Lorimer 1991) Not seen for this study
Fissure	V	A1997.10.ee	Rib cage	Rib	rib fragment	Identified by ZooMS
Unspecified midden	IV 90	A1997.10.ai(a)	Upper limbs	Shoulder	Clavicle, left	
Unspecified midden	IV 90	A1997.10.ai(b)	Rib cage	Rib	15 Rib fragments	
Unspecified midden	IV 90	A1997.10.ai(e)	Lower limbs	Leg	2 fragments of possible tibia	Detailed in fiche (Connock et al. 1991) and viewed for this study
Unspecified midden	IV 90	A1997.10.ai(l)	Upper limbs	Shoulder	Clavicle, left, shaft fragment	Detailed in fiche (Connock et al. 1991) not viewed for this study. Current location unknown
Unspecified midden	IV90	A1997.10.ai(m)	Upper limbs	Arm	Fragment of trochlea of humerus, left	Detailed in fiche (Connock et al. 1991) not viewed for this study. Current location unknown

Context	Context number	Skeleton number	Part of body 1	Part of body 2	Bone	Notes
Unspecified midden	IV 90	A1997.10.ai(d)	Vertebral column	Spine	1st Thoracic vertebra fragment	
Unspecified midden	IV 90	A1997.10.ai(g)	Vertebral column	Spine	?2nd Thoracic vertebra body	
Unspecified midden	IV 90	A1997.10.ai(h)	Vertebral column	Spine	?3rd Thoracic vertebra body	
Unspecified midden	IV 90	A1997.10.ai(i)	Vertebral column	Spine	?4th Thoracic vertebra body	
Unspecified midden	IV 90	A1997.10.ai(j)	Vertebral column	Spine	?5th Thoracic vertebra	
Unspecified midden	IV 90	A1997.10.ai(k)	Vertebral column	Spine	Cervical vertebra	
Unspecified midden	IV 90		Upper limbs	Arm	Distal fragment of ?right humerus	Detailed in fiche (Connock et al. 1991) not viewed for this study. Current location unknown
Unspecified midden	IV 94	A1997.10.ak	Extremities	Hand	Proximal phalanx	
Unspecified midden	IV 99	A1997.10.an(a)	Vertebral column	Spine	Atlas, C1	
Unspecified midden	IV 99	A1997.10.an(b)	Extremities	Foot	Metatarsal, 4, left	
Unspecified midden	IV 99	A1997.10.an(c)-1	Rib cage	Rib	5 Rib fragments	
Unspecified midden	IV 99	A1997.10.an(c)-2	Extremities	Foot	Metatarsal	
Unspecified midden	IV90	A1997.10.ai(c)	Extremities	Foot	Metatarsal anterior fragment	
Unspecified midden	IV90	A1997.10.ai(f)	Vertebral column	Spine	?6th Thoracic vertebra	

Context	Context number	Skeleton number	Part of body 1	Part of body 2	Bone	Notes
Unspecified midden	IV 103	A1997.10.ec	Lower limbs	Pelvis	Acetabulum and illiopubic ramus, right?	
Unspecified midden	XII		Skull	Cranium	3 fragments of skull	(Lorimer 1991) Not seen for this study
Unspecified midden	XII		Skull	Cranium	maxilla, left	(Lorimer 1991) Not seen for this study
Unspecified midden	XII		Skull	Cranium	frontal, left	(Lorimer 1991) Not seen for this study
Unspecified midden	XII		Skull	Jaw	Incisor and 1 other tooth	(Lorimer 1991) Not seen for this study

Appendix 3.2 Newly recognised human remains

Newly recognised human remains from the GMRC catalogue. Note that "Context number" in the GMRC Catalogue Entry column is actually the find number and "find number" is actually the context number. The Context column refers to the actual context number.

GMRC catalogue entry				Context	Observations based on current analysis
ID number	**Object name**	**Materials**	**Description**		
A.1997.10.ap	bone fragment	bone	Bone fragment, from Carding Mill Bay, Oban, find number XXIIII, context number 3, site number 125/BO/01.	XXIV Earlier shell midden	Human distal hand phalanx, complete. Detailed by Lorimer in fiche (Connock et al. 1991) but not labelled as human in GMRC
A.1997.10.at	bone	bone	Bone, intact, from Carding Mill Bay, Oban, find number XXIIII, context number 10, site number 125/BO/01.	XXIV Earlier shell midden	Human proximal hand phalanx, 2nd or 3rd. Detailed by Lorimer in fiche (Connock et al. 1991) but not labelled as human in GMRC
A.1997.10.da	bone fragment	bone	Bone fragment, from Carding Mill Bay, Oban, find number V, context number 106, site number 125/BO/01.	V Fissure	Human long bone shaft. Tibia.
A.1997.10.db	bone fragment	bone	Bone fragment, from Carding Mill Bay, Oban, find number V, context number 107, site number 125/BO/01.	V Fissure	Human long bone, fibula, midshaft fragment
A.1997.10.dc	complete bone	bone	Complete bone, from Carding Mill Bay, Oban, find number V, context 138, site number 125/BO/01.	V Fissure	Human 1st Metatarsal, right. Complete
A.1997.10.dd	complete bone	bone	Complete bone, from Carding Mill Bay, Oban, find number V, context number 139, site number 125/BO/01.	V Fissure	Human 2nd metatarsal, right. Complete
A.1997.10.df	bone fragment	bone	Bone, from Carding Mill Bay, Oban, find number V, context number 105, site number 125/BO/01.	V Fissure	Human femur sampled for isotope analysis by R. Schulting.

GMRC catalogue entry				Context	Observations based on current analysis
ID number	Object name	Materials	Description		
A.1997. 10.dg	bone fragments	bone	Bone remains, 3, from Carding Mill Bay, Oban, find number V, context number 141, site number 125/BO/01.	V Fissure	Human vertebra fragment and ?Human rib fragments

Appendix 3.3 Specimens not subject to primary analysis

Specimens not seen during visit to GMRC and therefore no primary analysis completed for them.

GMRC catalogue entry				**Context**	**Reason for no primary analysis during visit to GMRC**	**Included in this study?**
ID number	**Object name**	**Materials**	**Description**			
A.1997.10.t	bone fragment	bone	Bone remains, two, from Carding Mill Bay, Oban, find number XXIII, context number 1, site number 125/BO/01.	XXIII Fissure	Labelled as human remains but not seen during visit to GMRC	Not at this time
A.1997.10.u	bone fragment	bone	Bone remains, two, from Carding Mill Bay, Oban, find number XXIII, context number 4, site number 125/BO/01.	XXIII Fissure	Labelled as human remains but not seen during visit to GMRC	Not at this time
A.1997.10.x	bone fragment	bone	Bone fragment, from Carding Mill Bay, Oban, find number XXIII, context number 7, site number 125/BO/01.	XXIII Fissure	Labelled as human remains but not seen during visit to GMRC	Not at this time
A.1997.10.z	bone fragment	bone	Bone remains, three, from Carding Mill Bay, Oban, find number XXIII, context number 10, site number 125/BO/01.	XXIII Fissure	Labelled as human remains but not seen during visit to GMRC	Not at this time
A.1997.10.s	human mandible and teeth	human bone, teeth	Human mandible with 9 teeth in situ, from Carding Mill Bay, Oban, find number XXIII, site number 125/BO/01.	XXIII Fissure	Labelled as human remains but not seen during visit to GMRC. Subsequently seen a photograph so added to general catalogue	Yes
A.1997.10.aa	bone fragment	bone	Bone remains, two, from Carding Mill Bay, Oban, find number XXIII, context number 12, site number 125/BO/01.	XXIII Fissure	Labelled as human remains but not seen during visit to GMRC. Subsequently seen a photograph so added to general catalogue	Yes

GMRC catalogue entry				Context	Reason for no primary analysis during visit to GMRC	Included in this study?
ID number	**Object name**	**Materials**	**Description**			
A.1997.10.dl	bone fragments	bone	Bone remains, four fragments, from Carding Mill Bay, Oban, find number XII, context number 4, site number 125/BO/01.	XII Unspecified shell midden	Removed from collection for ZooMS analysis by O. Craig. Identified as human using ZooMS and seen in lab in York	No- cannot be anatomically identified
A.1997.10.dx	bone fragments	bone	Bone remains, seven fragments, from Carding Mill Bay, Oban, find number III, context number 46, site number 125/BO/01.	III Cist	Removed from collection for ZooMS analysis by O. Craig. Identified as human using ZooMS and seen in lab in York	Yes
A.1997.10.ee	bone fragments	bone	Bone remains, eleven fragments, from Carding Mill Bay, Oban, find number V, context number 141, site number 125/BO/01.	V Fissure	Removed from collection for ZooMS analysis by O. Craig. Identified as human using ZooMS and seen in lab in York	Yes
A.1997.10.eg	bone fragment	bone	Bone fragment, from Carding Mill Bay, Oban, find number VII, context 42, site number 125/BO/01.	VII Earlier shell midden	Removed from collection for ZooMS analysis by O. Craig. ZooMS suggests not human.	Not at this time
A.1997.10.ey	bone fragment	bone	Bone fragment, from Carding Mill Bay, Oban, find number XVII, context number 2, site number 125/BO/01.	XVII Earlier shell midden	Removed from collection for ZooMS analysis by O. Craig. ZooMS suggests not human.	Not at this time
A.1997.10.v	bone fragment	bone	Bone remains, four, from Carding Mill Bay, Oban, find number XXIII, context number 5, site number 125/BO/01.	XXIII Fissure	Removed from collection for ZooMS analysis by O. Craig. ZooMS suggests not human.	Not at this time
A.1997.10.ad			Metatarsal from context VII: 112	VII Earlier shell midden	Removed for isotope analysis by R. Schulting and M. Richards	Yes
A.1997.10.ak			Phalanx from context IV: 94	IV unspecified midden deposit	Removed for isotope analysis by R. Schulting and M. Richards	Yes

GMRC catalogue entry				Context	Reason for no primary analysis during visit to GMRC	Included in this study?
ID number	**Object name**	**Materials**	**Description**			
A1997.10.ai			Clavicle, left shaft fragment and fragment of trochlea of left humerus	IV unspecified midden deposit	Detailed in fiche (Connock et al. 1991). Current location unknown	Yes
A1997.10.ai(e)			2 fragments of tibia	IV unspecified midden deposit	Detailed in fiche (Connock et al. 1991). Viewed for this study	Yes
			Distal fragment of ?right humerus	IV 90 unspecified midden deposit	Detailed in fiche (Connock et al. 1991). Current location unknown	Yes
A.1997.10.dm			phalanx from context XIV:1	XIV Earlier shell midden	Removed for isotope analysis by R. Schulting and M. Richards	Yes
A.1997.10.dn			shaft of metacarpal from context XV:1	XV Earlier shell midden	Removed for isotope analysis by R. Schulting and M. Richards	Yes
A1997.10.dp			distal phalanx from context XVII:1	XVII Earlier shell midden	Removed for isotope analysis by R. Schulting and M. Richards	Yes
A1997.10.ga			shaft of adult humerus from III:74	III Cist	Removed for isotope analysis by R. Schulting and M. Richards	Yes
			shaft of adult femur from V:105 (same sample as A1997.10.df)	V Fissure		
			parietal fragment from VII:130	VII Earlier shell midden		
			immature scapula from X:1	X Later shell midden		
			left 3rd metatarsus from XXIII	XXIII Fissure		

GMRC catalogue entry				Context	Reason for no primary analysis during visit to GMRC	Included in this study?
ID number	**Object name**	**Materials**	**Description**			
	Bone fragment	Bone	Three fragments of skull bone, one fragment of left maxilla, fragment of left frontal and two teeth	XII unspecified midden deposit	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	7 permanent teeth, from a juvenile aged between 10-11 years , 8 rib shaft fragments from a child, a fragment of juvenile pelvis and 1 adult rib fragment.	X Later shell midden	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	Shaft of a metacarpal, shaft fragment of a long bone- possibly ulna.	VII Earlier shell midden	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	Upper and lower 1st premolars	XXIII Fissure	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
A.1997.10.ew	Bone fragment	Bone	Metatarsal 1 ?left	XXIII Fissure	Detailed by Lorimer (1991, 3-4) and seen via photo for this study	Yes
	Bone fragment	Bone	3 non-adult rib fragments	XXIII Fissure	Detailed by Lorimer (1991, 3-4) in human bone report but not mentioned further in any analysis. Current location unknown	Yes
A.1997.10.s	Bone fragment	Bone	Mandible and teeth	XXIII Fissure	Detailed by Lorimer (1991, 3-4) and seen via photo for this study	Yes
A.1997.10.aa	Bone fragment	Bone	Non-adult lumbar vertebra	XXIII Fissure	Detailed by Lorimer (1991, 3-4) and seen via photo for this study	Yes
	Bone fragment	Bone	Atlas vertebra	XXIII Fissure	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	6th and 7th cervical vertebrae + 1 unknown	XXIII Fissure	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	1st and 2nd thoracic vertebrae	XXIII Fissure	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes

GMRC catalogue entry				Context	Reason for no primary analysis during visit to GMRC	Included in this study?
ID number	**Object name**	**Materials**	**Description**			
	Bone fragment	Bone	5 rib fragments	XXIII Fissure	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	3 fragments of scapula	XXIII Fissure	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	fragment of right humerus shaft	XXIII Fissure	Detailed by Lorimer (1991, 3-4). Current location unknown	Yes
	Bone fragment	Bone	3 fragments of scapula	XXIV Fissure	Detailed in fiche (Connock et al. 1991). Current location unknown	Yes

Appendix 4

Appendix 4.1 Cist burial compared to all other contexts

In this chi-square comparison the expected frequencies (f_e) of specimens will be calculated using the remains found within the cist context as a comparative, as the cist represents the frequency of elements surviving in a complete inhumation burial which has been subject to burial and subsequent taphonomic processes. The specimens present in the other contexts will be the observed frequencies (f_o) as it is these that need to be compared to the cist remains in order to test whether they differ significantly from the cist burial or not. The null hypothesis (H0) is that there is no difference between the expected frequency of skeletal elements in the cist burial and the observed frequencies in the other contexts, ie. H0: $f_e = f_o$. An assumption made by the chi-square test is that the frequencies involved are greater than 5. As this is an archaeological sample, the frequencies of which has been further reduced to account for MNI, in almost every case the frequency is less than 5. Therefore a correction will be applied to the chi-square analysis to reduce the chance that the results could provide a false rejection of the null hypothesis. Yates' correction for continuity has been applied in this case, which reduces the difference between f_e and f_o in order to make the test more conservative (Madrigal 2012, 175). Yates' correction has been criticised for being overly conservative (see Madrigal 2012, 175 for discussion) but in this case it is felt that an overly conservative result would be no bad thing given the nature of the archaeological assemblage and its recovery.

Fissure	**f_o**	**f_e**	**$f_0 - f_e$**	**$f_0 - f_e - 0.5$ (Yate correction)**	**$(f_0 - f_e - 0.5)^2/f_e$**
Skull	0.5	1.10	-0.60	-1.10	1.10
Vertebral Column	5.5	1.98	3.52	3.02	4.62
Rib Cage	5.5	5.93	-0.43	-0.93	0.15
Upper Limbs	4	4.18	-0.18	-0.68	0.11
Lower Limbs	1.5	5.49	-3.99	-4.49	3.68
Extremities	3	1.32	1.68	1.18	1.06
Total	20			X^2_c	**10.71**
Unspecified midden	**f_o**	**f_e**	**$f_0 - f_e$**	**$f_0 - f_e - 0.5$ (Yate correction)**	**$(f_0 - f_e - 0.5)^2/f_e$**
Skull	5	2.31	2.69	2.19	2.08
Vertebral Column	8	4.15	3.85	3.35	2.70

Rib Cage	20	12.46	7.54	7.04	3.98
Upper Limbs	2	8.77	-6.77	-7.27	6.03
Lower Limbs	3	11.54	-8.54	-9.04	7.08
Extremities	4	2.77	1.23	0.73	0.19
Total	42			$X^2{}_c$	**22.05**
Later shell midden	**f_o**	**f_e**	**f_0 - f_e**	**f_0 - f_e - 0.5 (Yate correction)**	**$(f_0 - f_e - 0.5)^2/f_e$**
Skull	0.3333333	0.26	0.08	-0.42	0.70
Vertebral Column	0	0.46	-0.46	-0.96	2.00
Rib Cage	3	1.38	1.62	1.12	0.90
Upper Limbs	0.3333333	0.97	-0.64	-1.14	1.34
Lower Limbs	1	1.28	-0.28	-0.78	0.48
Extremities	0	0.31	-0.31	-0.81	2.12
Total	4.6666666			$X^2{}_c$	**7.53**
Earlier shell midden	**f_o**	**f_e**	**f_0 - f_e**	**f_0 - f_e - 0.5 (Yate correction)**	**$(f_0 - f_e - 0.5)^2/f_e$**
Skull	2	0.55	1.45	0.95	1.64
Vertebral Column	1	0.99	0.01	-0.49	0.24
Rib Cage	0	2.97	-2.97	-3.47	4.05
Upper Limbs	1	2.09	-1.09	-1.59	1.21
Lower Limbs	0	2.75	-2.75	-3.25	3.84
Extremities	6	0.66	5.34	4.84	35.54
Total	10			$X^2{}_c$	**46.52**

Table 28: Chi-square analysis comparing cist burial with other contexts at Carding Mill Bay. H0 is that the cist burial deposits do not differ from the other contexts' burial remains. $X^2{}_c$ is the corrected chi-square value

Calculations involved in the chi-square analysis are presented in Table 28. The degrees of freedom (df) for this analysis was 5 as there are six skeletal element categories (known as all *a* outcomes) and df= *a*-1 (Madrigal 2012, 167). The null hypothesis is rejected at all p values in both the unspecified midden and the earlier shell midden and the results are summarised in Table 13.

Appendix 4.2 Unspecified midden compared to earlier shell midden

Further chi-square analysis comparted the distribution of skeletal elements between the unspecified midden and the earlier shell midden. H0 is that the skeletal distribution in the unspecified midden is the same as that in the earlier shell midden. The same assumptions and corrections as above are applied in this analysis. The proportion of each skeletal element in the unspecified midden (Table 29) was used to calculate f_e for the analysis (Table 30).

Area of Skeleton	**Frequency**	**Proportion of the assemblage**
Skull	5.0	0.1190
Vertebral Column	8.0	0.1905
Rib Cage	20.0	0.4762
Upper Limbs	2.0	0.0476
Lower Limbs	3.0	0.0714
Extremities	4.0	0.0952
Total	**42**	**1.00**

Table 29: Percentage representation of skeletal elements in unspecified midden deposit at Carding Mill Bay

Earlier shell midden	**f_o**	**f_e**	**f_0 - f_e**	**f_0 - f_e - 0.5 (Yate correction)**	**$(f_0 - f_e - 0.5)^2/f_e$**
Skull	2	1.19	0.81	0.31	0.08
Vertebral Column	1	1.90	-0.90	-1.40	1.04
Rib Cage	0	4.76	-4.76	-5.26	5.81
Upper Limbs	1	0.48	0.52	0.02	0.00
Lower Limbs	0	0.71	-0.71	-1.21	2.06
Extremities	6	0.95	5.05	4.55	21.71
Total	10			**X^2_c**	**30.71**

Table 30: Chi-square analysis comparing unspecified midden with earlier shell midden at Carding Mill Bay. H0 is that the unspecified midden deposits do not differ from those in the earlier shell midden. X^2_c is the corrected chi-square value

The calculations are presented in Table 30. The degrees of freedom (df) for this analysis was 5 as there are six skeletal element categories (known as all *a* outcomes) and df= *a*-1 (Madrigal 2012, 167). The result leads to a rejection of the null hypothesis at p=0.05, p=0.02 and p=0.01.

Appendix 5

Appendix 5.1 Inventory of Oronsay human remains

Inventory of human bone specimens from Oronsay shell middens. Source of published material (Meiklejohn and Denston 1987; Meiklejohn et al. 2005) and new observations as part of this study.

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Caisteal nan Gillean II	12162	Trench P	Extremities	Hand	Medial phalanx 2, right	complete	1			
Caisteal nan Gillean II	1689	Trench P	Extremities	Hand	Medial phalanx 5, left	complete	1			
Caisteal nan Gillean II	1281	Trench P	Extremities	Foot	Metatarsal 3, left	shaft and proximal extremity	1			
Caisteal nan Gillean II	1639	Trench P	Extremities	Foot	Medial phalanx 5, right	damaged proximal extremity	1			slight charcoal sheen- partially burnt
Caisteal nan Gillean II	1282	Trench P	Vertebral column	Vertebrae	Lumbar vertebra, 5	largely complete though damaged	1		distal epiphysis fused by line visible ie. aged as young adult <25 years	

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Priory Midden	9022	"Sondage area" main trench	Extremities	Hand	Medial or proximal phalanx	missing proximal extremity	1		may be juvenile as lacking development of lateral margin	
Cnoc Coig	15294	Bone group 2A	Extremities	Hand	Distal phalanx 5, right	complete	1	18238		
Cnoc Coig	15382	Bone group 2A	Extremities	Hand	Medial phalanx 5 left	complete but slight damage to proximal extremity	1	15742		
Cnoc Coig	18238	Bone group 2A	Extremities	Hand	middle phalanx 5 right	complete	1	15294		
Cnoc Coig	18279	Bone group 2A	Extremities	Hand	middle phalanx 5 left	proximal extremity and shaft	1			
Cnoc Coig	18282	Bone group 2A	Vertebral column	Vertebrae	Cervical vertebra, ?4	deteriorated fragment of body	1			
Cnoc Coig	18284	Bone group 2A	Extremities	Hand	metacarpal 1 right	complete	1			
Cnoc Coig	18287	Bone group 2A	Vertebral column	Vertebrae	Axis, cervical vertebra 2	two articulating fragments	2		arthritic lipping	
Cnoc Coig	21024	Bone group 2A	Extremities	Hand	distal phalanx 2 right	complete	1	low certainty 17193		
Cnoc Coig	21039	Bone group 2A	Extremities	Foot	cuneiform 2 right	badly deteriorated	1			
Cnoc Coig	21142	Bone group 2A	Extremities	Hand	proximal phalanx 5 right	complete	1			

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	25574	Bone group 2A	Extremities	Hand	proximal phalanx 4 or 5 right	fragment of shaft and distal extremity portion	1			
Cnoc Coig	18283	Bone Group 2A, sieved	Extremities	Hand	proximal phalanx 2 left	proximal extremity and shaft	1			
Cnoc Coig	15647	Bone group 2B	Extremities	Hand	Proximal phalanx	shaft fragment	1			
Cnoc Coig	15742	Bone group 2B	Extremities	Hand	Distal phalanx 5, left	complete	1	15382		
Cnoc Coig	21089	Bone group 2B	Extremities	Hand	metacarpal 3 right	distal extremity missing	1	low certainty 17203		
Cnoc Coig	21091	Bone group 2B	Extremities	Foot	metatarsal 5 right	proximal extremity and shaft and damaged fragment of distal epiphysis	1			
Cnoc Coig	17173	Bone group 3B	Extremities	Foot	middle phalanx	fragmentary shaft tentatively identified	1			
Cnoc Coig	17109	Bone group 3A	Vertebral column	Spine	Vertebra	part of the posterior of a vertebra or sacral segment	1			
Cnoc Coig	17124	Bone group 3A	Skull	Tooth	Maxillary molar 3 right	complete	1			

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	17137	Bone group 3A	Extremities	Foot	proximal phalanx 2 or 3 right	distal extremity and shaft	1			
Cnoc Coig	17142	Bone group 3A	Extremities	Hand	metacarpal 2 left	proximal extremity, shaft and fragment of distal extremity	2	17187 and 17203		
Cnoc Coig	17145	Bone group 3A	Extremities	Foot	proximal phalanx 2 right	complete	1			
Cnoc Coig	17157	Bone group 3A	Upper limbs	shoulder	clavicle left	complete	1	22560		male
Cnoc Coig	17168	Bone group 3A	Lower limbs	Leg	Tibia, right	shaft and proximal epiphysis fragments	2			
Cnoc Coig	17187	Bone group 3A	Extremities	Hand	metacarpal 2 right	proximal extremity and fragmentary shaft	1	17142		
Cnoc Coig	17193	Bone group 3A	Extremities	Hand	middle phalanx 2 right	complete	1	low certainty 21024		
Cnoc Coig	17194	Bone group 3A	Extremities	Hand	middle phalanx 2 left	complete	1			
Cnoc Coig	17201	Bone group 3A	Extremities	Hand	middle phalanx 2 right	distal extremity and most of shaft	1			
Cnoc Coig	17203	Bone group 3A	Extremities	Hand	metacarpal 3 left	complete	1			

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	17204	Bone group 3A	Extremities	Foot	Cuboid left	complete	1	17119		
Cnoc Coig	17234	Bone group 3A	Extremities	Foot	Talus right	most of anterior/ superior portion and two fragments	3			
Cnoc Coig	22560	Bone group 3A	Upper limbs	shoulder	Clavicle right	two articulating fragments of shaft	1	17157?		? Male based on size similarity to 17157
Cnoc Coig	20243	Bone Group 3A, seived	Extremities	Foot	Terminal phalanx 4	slight damage distally	1			
Cnoc Coig	17119	Bone group 3B	Extremities	Foot	Cuneiform lateral or 3rd left	some slight damage to plantar surface and dorsal surface	1	17204		
Cnoc Coig	8135	Loose Bone: Central area lane 5	Skull	Tooth	Maxillary molar 3 left	complete	1			
Cnoc Coig	15057	Loose Bone: Lane H and I between groups 2A and 3	Extremities	Hand	Proximal phalanx	shaft fragment	1			

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	15112	Loose Bone: Lane H and I between groups 2A and 3	Vertebral column	Spine	Cervical vertebra 2	dens of an axis of juvenile vertebra and 12 other fragments of vertebra and possibly carpals.	13		non adult	
Cnoc Coig	17047	Loose Bone: Lane I above group 3A	Lower limbs	Leg	Patella?	uncertain identity pathological fragment of patella? ?human	1			
Cnoc Coig	10638	Loose Bone: Peacock's Pits	Skull	Tooth	Mandibular molar 2 right	complete	1			
Cnoc Coig	12100	Loose Bone: Peacock's Pits	Skull	Tooth	Molar crown	crown only	1			
Cnoc Coig	12140	Loose Bone: Peacock's Pits	Extremities	Foot	Proximal phalanx 2 right	proximal extremity and shaft	1			
Cnoc Coig	4094	Minor bone group 1	Skull	Cranium	Cranial vault fragment, parietal	parietal fragment showing burning	1			
Cnoc Coig	7032	Minor bone group 1	Upper limbs	Shoulder	Clavicle left	largely complete but badly crushed	1			

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	18089	Minor bone group 4	Skull	Cranium	frontal vault?	frontal vault fragment	1			
Cnoc Coig	18104	Minor bone group 4	Upper limbs	shoulder	clavicle left	shaft and distal extremity	1			?female
Cnoc Coig	18143	Minor bone group 4	Skull	Cranium	temporal, right	three fragments of right temporal	3			
Cnoc Coig	18147	Minor bone group 4	Extremities	Foot	proximal phalanx 1 right	complete	1			
Cnoc Coig	16091	Minor bone group 5	Lower limbs	Pelvis	pelvis	ilium, acetabulum and superior ischium, left	1		non adult	female
Cnoc Coig	16103	Minor bone group 5	Rib cage	Rib	Rib	small to moderate pieces of non-diagnostic rib	6			
Cnoc Coig	General Finds	UIII: Outside main midden	Extremities	Hand	Metacarpal?	partial shaft and epiphysis	2			"Found in seive, material from around bone cluster". Labelled Sept 11 1975.

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	8254	UIII: Outside main midden	Skull	Cranium	Cranium?	?	1			?Human? Flat fragment 8.2mm thick. Some curvature. One side has a notch/ groove running between the surfaces. Labelled Sept 11 1975.
Cnoc Coig	8255	UIII: Outside main midden	Lower limbs	Leg	?Long bone		1			?Human. Labelled Sept 11 1975.
Cnoc Coig	8256	UIII: Outside main midden	Upper limbs	Arm	Ulna? Or Humerus?	Distal 1/2	1		Non adult?	?Human. Labelled Sept 11 1975.
Cnoc Coig	8257	UIII: Outside main midden	Skull	Cranium	?Occipital		1	8258		Labelled Sept 11 1975. Mould growing on specimen.
Cnoc Coig	8258	UIII: Outside main midden	Skull	Cranium	?Occipital		1	8257		Labelled Sept 11 1975.

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	8259	UIII: Outside main midden	Rib cage	Rib	?Rib		2			?Human. Labelled Sept 11 1975.
Cnoc Coig	8260	UIII: Outside main midden	Vertebral column	Spine	?Lumbar vertebra		9			?Human. Labelled Sept 11 1975. Very crumbly and dirty.
Cnoc Coig	8261	UIII: Outside main midden	Vertebral column	Spine	Thoracic vertebra	Part of body, superior articular facets and lamina	3			Labelled Sept 11 1975.
Cnoc Coig	8263	UIII: Outside main midden	Vertebral column	Spine	?vertebra	spinous process	1			?Human. Labelled Sept 11 1975. Possible vertebra but has some lipping which questions this.
Cnoc Coig	8265	UIII: Outside main midden	Rib cage	Rib	?Rib		9			?Human. Labelled Sept 11 1975.
Cnoc Coig	8266	UIII: Outside main midden	Vertebral column	Spine	Lumbar vertebra	superior articular facet and lamina	1			Labelled Sept 11 1975.

Midden	Context number	Position	Part of body 1	Part of body 2	Bone	Portion	Number of fragments	Associated with?	Age notes	Other observations
Cnoc Coig	8268	UIII: Outside main midden	Vertebral column	Spine	Cervical vertebrae	Spinous process x1, articular facet x2, vertebral body x 2	5			Labelled Sept 11 1975. Mould growing on specimens.

Appendix 6

Appendix 6.1 Chi-square analysis comparing trench U and minor bone groups

As in previous chi-square analysis Yate's correction has been applied due to small sample sizes. Comparison of the skeletal elements found in the minor bones groups and isolated bone at Cnoc Coig with the bones found in trench U will inform whether these remains might be the result of a similar taphonomic history. The null hypothesis is that there is no difference between the expected frequency of the remains from trench U and the observed frequencies from the loose bone and minor bone groups. The workings are presented in Table 31 and show that $X^2_c = 2.56$ which does not allow the null hypothesis to be rejected. If the null hypothesis cannot be rejected then the two sets of bones are not significantly different and potentially arose from the same taphonomic history.

Isolated bones and minor bone groups	f_o	f_e	$f_0 - f_e$	$f_0 - f_e - 0.5$ **(Yate correction)**	$(f_0 - f_e - 0.5)^2/f_e$
Skull	1	1.00	0.00	-0.50	0.25
Vertebral Column	2	2.00	0.00	-0.50	0.13
Rib Cage	2	3.67	-1.67	-2.17	1.28
Upper Limbs	0.67	0.33	0.34	-0.16	0.08
Lower Limbs	0.67	0.33	0.34	-0.16	0.08
Extremities	1.33	0.33	1.00	0.50	0.74
Total	7.67			X^2_c	**2.56**

Table 31: Workings of the chi-square analysis comparing trench U and the isolated and minor bone groups at Cnoc Coig, Oronsay

Appendix 6.2 Chi-square analysis comparing the major and minor bone groups

Comparison of the skeletal elements found in the major bones groups at Cnoc Coig with the bones found in the minor bone groups, isolated bone and trench U will inform whether these remains might be the result of a similar taphonomic history. The null hypothesis is that there is no difference between the expected frequency of the remains from groups 2 and 3 and the observed frequencies from the loose bone, minor bone groups and trench U. The workings are presented in Table 32 and show that $X^2_c = 36.81$ for Group 2 and $X^2_c = 25.98$ for Group 3 which does allow the null hypothesis to be rejected. If the null hypothesis is rejected then the two sets of bones are significantly different and potentially arose from different taphonomic histories.

Group 2	f_o	f_e	$f_0 - f_e$	$f_0 - f_e - 0.5$ (Yate correction)	$(f_0 - f_e - 0.5)^2/f_e$
Skull	0	0.70	-0.70	-1.20	2.06
Veterbral Column	0.67	1.39	-0.72	-1.22	1.07
Rib Cage	0	2.09	-2.09	-2.59	3.21
Upper Limbs	0	0.33	-0.33	-0.83	2.09
Lower Limbs	0	0.33	-0.33	-0.83	2.09
Extremities	4.67	0.51	4.16	3.66	26.28
Total	5.34			$X^2{}_c$	**36.81**
Group 3	f_o	f_e	$f_0 - f_e$	$f_0 - f_e - 0.5$ (Yate correction)	$(f_0 - f_e - 0.5)^2/f_e$
Skull	0.33	0.78	-0.45	-0.95	1.16
Veterbral Column	0.33	1.56	-1.23	-1.73	1.92
Rib Cage	0	2.34	-2.34	-2.84	3.45
Upper Limbs	0.67	0.37	0.30	-0.20	0.10
Lower Limbs	0.33	0.37	-0.04	-0.54	0.78
Extremities	4.33	0.57	3.76	3.26	18.57
Total	5.99			$X^2{}_c$	**25.98**

Table 32: Workings of chi-square analysis comparing the major bone groups from Cnoc Coig with the other bone groups at the site

Appendix 7

Appendix 7.1 Inventory of An Corran human remains

Catalogue Number	Context number	Part of body 1	Part of body 2	Bone	Portion	Complete?	Number of fragments	Age
AC0705	C31- Col 1 Sample A	Extremities	Hand	Phalanx	Intermediate phalanx? Distal and medial parts.	No		Non adult
AC0639	C31-BB4	Skull	Tooth	Canine, lower right	Developing crown	Yes		Juvenile
AC0640	C31-BB4	Skull	Jaw	Mandible, right	1st premolar alveolus	No		Juvenile
AC0641	C31-BB4	Skull	Jaw	Mandible, right	Canine alveolus	No		Juvenile
AC0632	C31-BB4	Vertebral Column	Spine	Lumbar vertebra 4	All present apart from tranverse processes	No		Adult
AC0615	C31-BB4	Upper Limbs	Arm	Humerus? Right?	Mesial 1/3	No		Non-adult
AC0630	C31-BB4	Extremities	Foot	Metatarsal, left?	Distal 1/3	No		
AC0626	C31-BB4	Extremities	Foot	Metatarsal 1		No		
AC0628	C31-BB4	Extremities	Foot	Metatarsal 3, left	Proximal 1/2	No		Adult
AC0629	C31-BB4	Extremities	Foot	Metatarsal 3, right		Yes		Adult
AC0631	C31-BB4	Extremities	Foot	Metatarsal 3, left	Proximal 1/2	No		Adult
AC0625	C31-BB4	Extremities	Foot	Navicular, right	Half remaining	No		
AC0627	C31-BB4	Extremities	Foot	Navicular, left		No		
AC0683	C36	Skull	Tooth	Mandible, premolar, left	Canine alveolus, d. 1st premolar present and 1st permanent molar in jaw.	No		Juvenile
AC0458	C36	Vertebral Column	Spine	Cervical vertebra	Vertebral body and part of articular facets	No		Adult
AC0118	C36	Rib Cage	Rib	Rib	Midshaft, showing costal groove	No		

Catalogue Number	Context number	Part of body 1	Part of body 2	Bone	Portion	Complete?	Number of fragments	Age
AC0283	C36	Upper Limbs	Shoulder	Scapula, right	Glenoid fossa	No		Adult
AC0270	C36	Upper Limbs	Arm	Ulna, left	Proximal 1/3	No		Adult
AC0117	C36	Extremities	Hand	Metacarpal 1, right?	Dorsal shaft and 1/2 of palmar shaft. Missing 1 epiphysis.	No		Juvenile
AC0908	C36- Col 1 Sample C	Skull	Tooth	Premolar	Developing permanent premolar, upper.	Yes		Juvenile
AC0909	C36- Col 1 Sample D	Skull	Tooth	Incisor, lower, right	Developing deciduous incisor 2, not really symmetrical in labial view.	Yes		Infant
AC0910	C36- Col 1 Sample D	Skull	Tooth	Incisor, lower, left	Deciduous lower incisor 2	Yes		Juvenile
AC0912.1	C36- Col 1 Sample D (a)	Rib Cage	Rib	Rib	Midshaft	No		
AC0912.3	C36- Col 1 Sample D (a)	Lower Limbs	Pelvis	Pelvis	Ischial acetabulem	No		
AC0912.2	C36- Col 1 Sample D (a)	Lower Limbs	Leg	Tibia	Proximal joint surface	No		Non adult
AC0912.4	C36- Col 1 Sample D (a)	Extremities	Foot	Cuneiform, intermediate, left		Yes		
AC0912.5	C36- Col 1 Sample D (a)	Extremities	Foot	Phalanx		Yes		Adult

Appendix 8

Appendix 8.1 Inventory of human remains at Havnø, Denmark

Bone number	Context number	Plan	Level	Part of body	Part of body 2	Bone	Side	Complete?	Portion (eg. distal 1/3)	Age	Pathology
ABFU				Lower Limb	Leg	Patella	Left	No	missing apex	adult	
AFH	102/97			Upper Limbs	Arm	Ulna	Left	No	proximal end, Medial 1/3, part of distal 1/3	adult	
ASC	99/100			Extremities	Foot	Phalanx, Distal		Yes		adult	
ATB	?			Skull	Jaw	Molar, 3rd, lower		Yes		adult	
DCC	99/100			Extremities	Foot	Phalanx, proximal		No	proximal 1/2	adult?	
EGQ	98/100			Extremities	Foot	Phalanx, Distal, 1st		Yes		adult	Porosity and bone formation indicative of osteoarthritis
JD	?			Upper Limbs	Arm	Radius	?	No	nearly complete	adolescent	
JSU				Extremities	Foot	Metatarsal, 3rd	Right	No	missing plantar part of proximal epiphysis and distal plantar epiphysis	adult?	
JZC	99/98			Extremities	Hand	Phalanx (2?), distal		Yes		adult	
LAJ				Extremities	Foot	Phalanx, proximal		Yes		adult	
LBB	98/98			Extremities	Foot	Talus	Left	No	present: part of head, calcaneal articular surfaces and the body	adult	Small patch of eburnation 0.21cm x 0.12cm on the lateral-distal edge of proximal facet. Very small amount of osteophyte formation on edge of facet - DJD
LBC-I				Lower Limb	Leg	Fibula	Right	No	middle 1/3	adult?	
LBD				Lower Limb	Leg	Tibia	Right	No	proximal epiphysis	adult?	

Bone number	Context number	Plan	Level	Part of body	Part of body 2	Bone	Side	Complete?	Portion (eg. distal 1/3)	Age	Pathology
LBU				Extremities	Hand	Phalanx (2?), intermediate		Yes		adult	
LDU-a	98/98			Lower Limb	Leg	Fibula	Right	No	middle 1/3	adult?	
LDU-b	98/98			Extremities	Foot	Phalanx, proximal		No	missing proximal epiphysis	adult	
LDY-2				Skull	Cranium	Cranium		No		juvenile	
LJU				Extremities	Hand	Phalanx (4?), intermediate		Yes		adult	
LMW				Extremities	Hand	Phalanx (4?), proximal		Yes	missing part of proximal epiphysis	adult	
LVO				Extremities	Hand	Phalanx (2?), proximal		Yes	missing proximal epiphysis	adult	
LVS	99/98			Extremities	Hand	Phalanx (4?), distal		No	missing top of distal tip	adult	
MBE				Extremities	Hand	Phalanx 5?, proximal		Yes		adult	
MCN	98/98	JJR		Extremities	Foot	Navicular	Right	No	tubercule, proximal articulation present. Partial distal articulation present	adult	
MDX				Extremities	Hand	Phalanx (4?), proximal		No	missing whole distal epiphysis	adult	
MSK	?			Upper Limbs	Arm	Ulna	Left	No	proximal end, Medial 1/3, part of distal 1/3	adult	
NPM-1				Extremities	Foot	Phalanx 5, distal and intermediate		Yes		adult	
NSV	100/98, NW		167	Lower Limb	Leg	Fibula	Left	No	proximal 1/4	adult	
NSW	100/98, NW		167	Extremities	Hand	Metacarpal 2	Left	No	proximal 1/2	adult?	

Bone number	Context number	Plan	Level	Part of body	Part of body 2	Bone	Side	Complete?	Portion (eg. distal 1/3)	Age	Pathology
NYA				Upper Limbs	Arm	Ulna	Right	No	Proximal 1/3, missing part of proximal epiphysis	adult	Additional bone formation on proximal epiphysis in centre. 1.8cm x 0.82 cm
OHA	100/99			Extremities	Foot	Metatarsal 2	Left	No	proximal 2/3 including base	adult	
OHL-3				Extremities	Foot	Metatarsal 2	Left	No	distal head	adult	
OHU	99/99, NE			Extremities	Hand	Phalanx (3?), distal		Yes		adult	
OTD				Upper Limbs	Arm	Ulna	Right	No	mid-shaft, distal. Missing distal epiphysis	adult	
PCE-a				Upper Limbs	Shoulder	Clavicle	Left	No	missing epiphyses	adult?	
PCE-b				Extremities	Hand	Phalanx (3?), proximal		Yes		adult	
QEK	100/98 NV			Lower Limb	Leg	Fibula	Left	No	medial 1/3	adult	
QQB	NE	QPT	177	Skull	Cranium	Parietal		No		juvenile	
RGB	100/98	NZL		Extremities	Hand	Hamate	Left	Yes	missing some edges	adult	
RNG				Extremities	Foot	Cuneiform, lateral (3rd)	Right	Yes		adult	
RTD	98/99			Extremities	Foot	Phalanx, proximal		Yes		adult	
THE	97/98	TFT		Extremities	Foot	Metatarsal 1	Right	Yes		adult	Osteophyte formation on plantar metatarsal head region and porosity shown on head and based region indicative of DJD
UBQ-a	98/98			Extremities	Hand	Metacarpal 3	Right	Yes		adult	
UBQ-b	98/98			Extremities	Hand	Phalanx 1, proximal	Right ?	Yes	missing one side of proximal epiphysis	adult	
UDE	98/98	UCL		Extremities	Foot	Phalanx 1, proximal	Right	Yes		adult	Some osteophyte formation and

Bone number	Context number	Plan	Level	Part of body	Part of body 2	Bone	Side	Complete?	Portion (eg. distal 1/3)	Age	Pathology
											porosity on the proximal facet indicative of DJD
UDH	98/98	UCL		Extremities	Hand	Phalanx (3?), intermediate		Yes		adult	
VNV	111/103			Skull	Cranium	Parietal, orbit	Left	No		juvenile	
XGX				Skull	Cranium	Occipital?		No		juvenile	
XPG	111/103	PUT		Skull	Cranium	Parietal	Left	No		juvenile	
XYB	109/103			Skull	Cranium	Occipital		No		juvenile	
YNWa				Skull	Jaw	Mandible, teeth		No	complete to posterior of mental foramen on right, anterial to the mental foramen on the left. Also present: Mandibular Right and left I1 and I2, Right and Left Canine, Right and left PM1 and PM2, left M1.	adult	RI1, RC, RPM2, LC show dental enamel hypoplasia Linear horizontal grooves and pits. Left side teeth are misaligned; PM2 and M1 are pushed in medially to the lingual side so that they lie behind C and PM1. No calculus or caries present.
YNWb				Skull	Jaw	Incisor, 1st, upper	Right	Yes		adult	

Appendix 9

Appendix 9.1 ZooMS analysis results

Context number	Plate Number	SpotA	SpotB	SpotC	Bar_A	Bar_B	Bar_C	Bar_D	Bar_E	Bar_F	Bar_G	Barcode_ ID	Notes
102/94	20130207_HavnoZooMS	E10	E15	E19		1427.7							
ADBC	20130207_HavnoZooMS	D5	D8	D11		1427.7							
ADDT	20130207_HavnoZooMS	A2	A5	A8		1427.7							
ADEO	20130207_HavnoZooMS	I21	I24	J1	None	None	none	None	none	none	2969	Indet	
ADPG-1	20130207_HavnoZooMS	G4	G7	G10		1427.7							
AEEA-1	20130207_HavnoZooMS	C15	C19	C22		1453.8							
AEEA-2	20130207_HavnoZooMS	C4	C8	C11		1427.7							
AEEF-1	20130207_HavnoZooMS	L10	L13	L16		1427.7							
AEJV-1	20130207_HavnoZooMS	I13	I16	I19		1453.7							
AEJV-2	20130207_HavnoZooMS	G22	H1	H6		1427.7							
AEJV-3	20130207_HavnoZooMS	G9	G12	G15		1453.8							
AEJW-1	20130207_HavnoZooMS	J23	K13	K16		1453.8							
AEJW-2	20130207_HavnoZooMS	A21	A24	B4		1427.6							
AEJX-1	20130207_HavnoZooMS	G13	G16	G19		1427.7							
AEJY-1	20130207_HavnoZooMS	E21	E24	F1		1427.7							
AEJY-2	20130207_HavnoZooMS	F2	F5	F8		1427.7							
AELF	20130207_HavnoZooMS	H18	H22	I1		1453.7							
AEWH	20130207_HavnoZooMS	K18	K21	K24		1453.7							
AHAO	20130207_HavnoZooMS	A1	A4	A7		1427.7							
AHCG	20130207_HavnoZooMS	J13	J16	J19		1453.7							
FLV	20130207_HavnoZooMS	D12	D15	D18	None	1477.7	1580	2115	none	none	2957	Human	

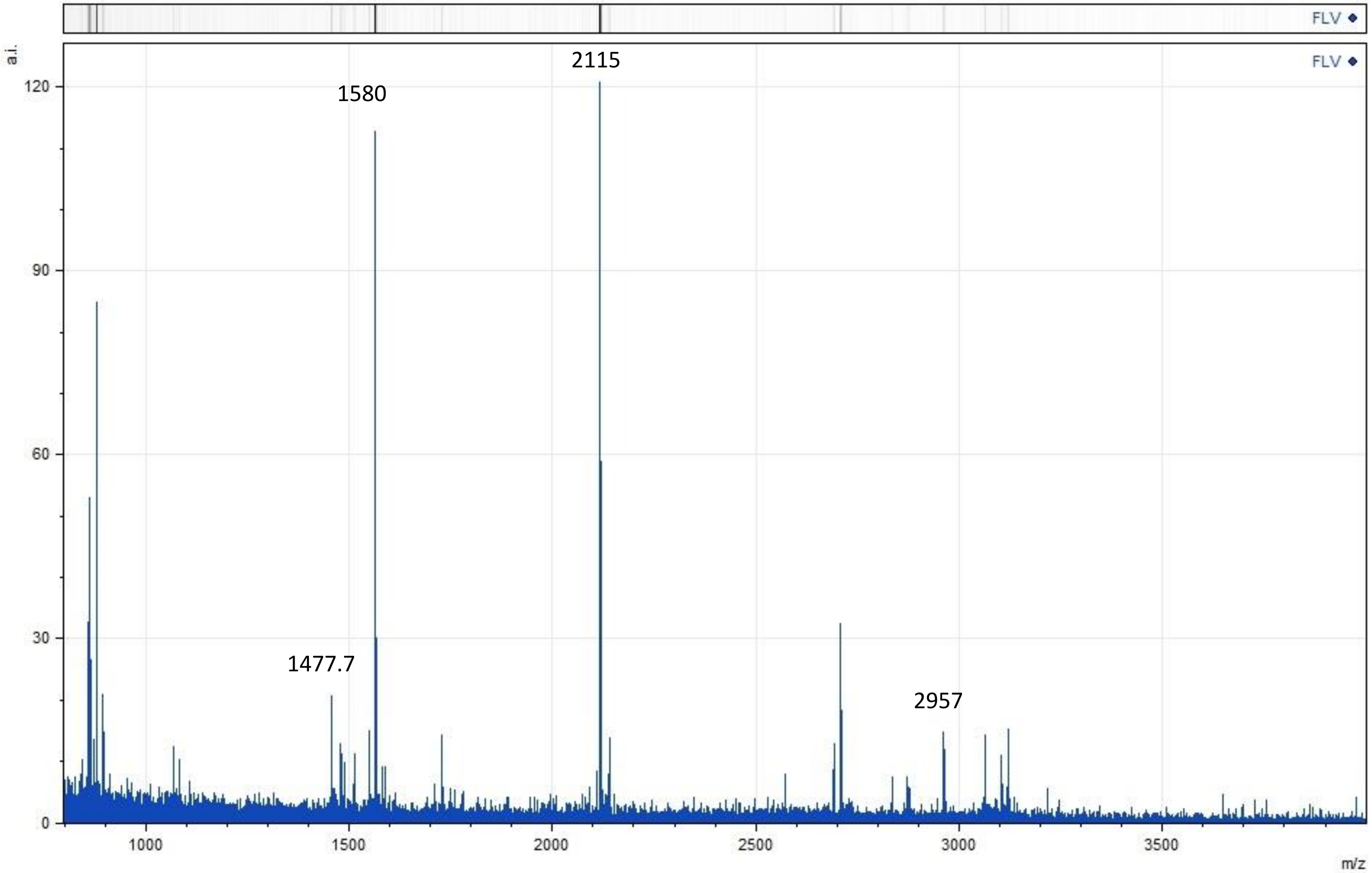
Context number	Plate Number	SpotA	SpotB	SpotC	Bar_A	Bar_B	Bar_C	Bar_D	Bar_E	Bar_F	Bar_G	Barcode_ ID	Notes
HCE	20130207_HavnoZooMS	F13	F16	F19		1427.7							
HLY	20130207_HavnoZooMS	C9	C12	C16	None	None	none	none	none	none	none	Indet	
HVT-1	20130207_HavnoZooMS	L11	L14	L17		1427.7							
HYU	20130207_HavnoZooMS	F12	F15	F18		1427.7							
JFD	20130207_HavnoZooMS	B22	C3	C7		1427.7							
JFJ-6	20130207_HavnoZooMS	B7	B12	B16		1427.7							
JHH	20130207_HavnoZooMS	A3	A6	A9		1427.7							
JKG	20130207_HavnoZooMS	K3	K7	K10		1453.7							Processing contamination/ mix-up
JQF	20130207_HavnoZooMS	G18	G21	G24		1453.8							
JRF	20130207_HavnoZooMS	C24	D1	D4		1427.7							
JZU	20130207_HavnoZooMS	B6	B15	B10		1453.7							
LNM	20130207_HavnoZooMS	D13	D16	D19		1427.7							
LSV	20130207_HavnoZooMS	A20	A23	B3	None	None	none	none	none	none	none	Indet	
MAE-1	20130207_HavnoZooMS	J18	J21	J24	None	None	none	none	none	none	none	Indet	
MAE-2	20130207_HavnoZooMS	A19	A22	B1		1453.7							
MBD	20130207_HavnoZooMS	E9	E13	E16		1427.7							
MCW-1	20130207_HavnoZooMS	L2	L5	L8		1453.7							
MFT	20130207_HavnoZooMS	F4	F7	F10		1453.7							
MGO	20130207_HavnoZooMS	J3	J6	J9		1427.7							
MMR	20130207_HavnoZooMS	F22	G3	G6		1427.7							
NPM-1	20130207_HavnoZooMS	I3	I6	I9		1427.7							
NXT	20130207_HavnoZooMS	B9	B13	B18		1427.7							
PDJ	20130207_HavnoZooMS	M4	M7	M10		1427.7							

Context number	Plate Number	SpotA	SpotB	SpotC	Bar_A	Bar_B	Bar_C	Bar_D	Bar_E	Bar_F	Bar_G	Barcode_ ID	Notes
PDL	20130207_HavnoZooMS	G5	G8	G11		1453.7							
PTC	20130207_HavnoZooMS	H4	H9	H13		1427.7							
PUU	20130207_HavnoZooMS	J4	J7	J10		1453.7							
TFV-6-1	20130207_HavnoZooMS	I4	I7	I10		1453.7							
TFV-6-2	20130207_HavnoZooMS	A12	A15	A18		1427.7							
UCE-1	20130207_HavnoZooMS	I12	I15	I18		1453.7							
UOT-1	20130207_HavnoZooMS	A11	A14	A17		1427.7							
UQD	20130207_HavnoZooMS	M5	M8	M11		1453.7							
VKJ-2	20130207_HavnoZooMS	I17	I20	I23		1453.68							
VPZ	20130207_HavnoZooMS	D22	E3	E6		1453.7							
VQB	20130207_HavnoZooMS	G23	H3	H7		1427.7							
VSL-1	20130207_HavnoZooMS	J14	J17	J20		1427.7							
VSL-2	20130207_HavnoZooMS	D23	E4	E7		1453.7							
VSO-1	20130207_HavnoZooMS	H12	H16	H21		1453.7							
VSO-2	20130207_HavnoZooMS	K15	K19	K22		1453.8							
VSZ	20130207_HavnoZooMS	F11	F14	F17		1427.7							
VTJ-1	20130207_HavnoZooMS	C17	C20	C23		1427.7							
VTJ-2	20130207_HavnoZooMS	H24	I2	I5		1427.7							
VTQ-1	20130207_HavnoZooMS	B19	B24	C1	None	None	none	none	none	none	none	Indet	
VTQ-2	20130207_HavnoZooMS	J5	J8	J11		1427.7							
VTX-1	20130207_HavnoZooMS	C6	C10	C13		1427.7							
VTX-2	20130207_HavnoZooMS	C14	C18	C21		1427.7							
VTX-3	20130207_HavnoZooMS	A10	A13	A16		1427.7							
VTY-2	20130207_HavnoZooMS	M6	M9	M12		1427.7							
WOM	20130207_HavnoZooMS	G14	G17	G20		1427.7							

Context number	Plate Number	SpotA	SpotB	SpotC	Bar_A	Bar_B	Bar_C	Bar_D	Bar_E	Bar_F	Bar_G	Barcode_ID	Notes
WTR	20130207_HavnoZooMS	I22	J12	J15		1453.7							
XBO-2	20130207_HavnoZooMS	I8	I11	I14		1427.7							
XGX	20130207_HavnoZooMS	L12	L15	L18		1453.7							
XLB	20130207_HavnoZooMS	L19	L22	M1		1453.7							
XTM	20130207_HavnoZooMS	D21	D24	E1	None	None	?	none	none	None	None	Indet	small peak at 1580?
XVT-2	20130207_HavnoZooMS	E12	E18	E22		1427.7							
XYO	20130207_HavnoZooMS	L1	L4	L7		1427.7							
YLP	20130207_HavnoZooMS	F3	F6	F9		1427.7							
YMK-1	20130207_HavnoZooMS	D2	D7	D10		1453.7							
YMK-2	20130207_HavnoZooMS	F21	F24	G2		1453.7							
YMK-3	20130207_HavnoZooMS	B21	C2	C5		1453.7							
YMK-4	20130207_HavnoZooMS	L20	L23	M2		1453.7							
YMM	20130207_HavnoZooMS	D3	D6	D9		1453.7							
YNZ	20130207_HavnoZooMS	K6	K9	K12		1427.7							
YPQ-1	20130207_HavnoZooMS	H10	H15	H19		1427.7							
YPQ-2	20130207_HavnoZooMS	F20	F23	G1		1427.7							
YQZ	20130207_HavnoZooMS	D14	D17	D20		1427.7							
YTW-1	20130207_HavnoZooMS	L21	L24	M3		1453.7							
YTW-2	20130207_HavnoZooMS	L3	L6	L9		1453.7							
YTW-3	20130207_HavnoZooMS	K1	K4	J22		1453.7							

Appendix 9.2 Mmass spectrum for FLV, human sample

This shows the mass spectrum for the Havnø sample identified as human, showing distinctively human peaks in peptide mass at 1477.7, 1580, 2115 and 2957.



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