Archaeological excavations in Moneen Cave, the Burren, Co. Clare

Insights into Bronze Age and post-medieval life in the west of Ireland

Marion Dowd

with contributions by

Fiona Beglane, Kirsten I. Bos, Ruth F. Carden, Matthew Collins, Rory Connolly, David Drew, Sheila Hamilton-Dyer, Thomas Kador, Johannes Krause, Elaine Lynch, Catriona McKenzie, Fran O'Keeffe, Ciarán Ó Murchadha, Helen Roche, Keri Rowsell, Michael Taylor and Åshild J. Vågene

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At home, as ever, my love and thanks to Fiachra (and Robin!).

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Prof. Matthew Collins (PhD in Geology, University of Glasgow) was recently named Niels Bohr Professor at the University of Copenhagen, a post that he will share with his current Chair in the Department of Archaeology at the University of York. At York he established BioArCh in 2003. His research focuses on ancient proteins, both the limits of survival and the potential for proteomics to address a wider range of research questions.

Rory Connolly graduated with a BSc (Hons) in Applied Archaeology from IT Sligo. He is currently carrying out doctoral research at the University of La Laguna, Tenerife. His work on the ERC funded PALEOCHAR project focuses on the application of soil micromorphology and organic chemistry techniques to investigate Middle Palaeolithic Neanderthal contexts in the Iberian Peninsula. He is interested in the complex relationships between past human societies and the environments in which they lived.

Dr Marion Dowd is a Lecturer in Prehistoric Archaeology at IT Sligo. Her MA (1997, UCC) and PhD (2004, UCC) focussed on the ritual use of caves in Ireland. She has directed excavations in several caves and has lectured and published widely on the subject of Irish cave archaeology. Her first book, *The archaeology of caves in Ireland* (Oxbow Books, 2015), won the Current Archaeology Book of the Year 2016 and the Tratman Award 2015.

Dr David Drew was a lecturer in the Geography Department in Trinity College Dublin from 1972 to 2011. His main research is in karst landscapes and karst hydrogeology with particular reference to Ireland, but he also has an interest into the application of techniques in karst geomorphology to determine past environments and dating of archaeological monuments in karst areas around the world. In retirement, his archaeologically oriented research continues in the Burren, Co. Clare and in Co. Sligo.

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Elaine Lynch studied Ceramic Design at the Limerick School of Art and Design from 2001 to 2005. She completed her Masters in History of Art and Architecture in 2006 and began her career in archaeology that year. Elaine completed an MPhil in Archaeology at UCC in 2011; the focus of her research was Grooved Ware in Ireland. She is currently working for Aegis Archaeology and Lynch Consultancy.

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Dr Ciarán Ó Murchadha is an independent scholar who has written widely on many aspects of Irish history. Among his research interests are land ownership and socio-economic change in the early modern period, and nineteenth century Ireland in all its aspects. He is particularly interested in local history as practiced everywhere on the island of Ireland, and has written much on the history of County Clare. His recent work on the Great Famine has been acclaimed internationally.

Helen Roche is a freelance consultant in prehistoric ceramics. She completed her MA on Late Neolithic Grooved Ware in 1995 at UCD. She has excavated as co-director at Knowth and as director on the Hill of Tara and published *Excavations at Knowth (2)* (Eogan and Roche 1997) and *Excavations at Raith na Rig, Tara, Co. Meath, 1997* (Roche 2002).

Keri Rowsell is a PhD student in BioArCh, part of the Department of Archaeology at the University of York. Her research concerns post-medieval poverty in England, which she is investigating through biomolecular and historical analyses of scurvy and diet. She previously worked for Prof. Matthew Collins as the ZooMS Research Technician on the CodeX project, based in York.

Prof. Michael Taylor completed a PhD at St. Mary's Hospital Medical School and then worked for a number of years in Experimental Pathology and Infectious Disease research at Imperial College London and later at University College London. In 2011 he joined the University of Surrey to pursue a long-standing interest in bioarchaeology. His current research deals with mycobacterial pathogens such as tuberculosis and leprosy, in particular, the origin and spread of these diseases in antiquity and their interaction with past human populations. Currently he is studying cases of leprosy from medieval Ireland with support from the British Academy and in collaboration with Eileen Murphy of Queen's University Belfast.

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Part I
The site, background and archaeological excavation

1. Introduction

Moneen Cave is a small underground chamber located near the summit of Moneen Mountain in Acres townland. It is 2.5km east-south-east of Ballyvaughan village, in the north Burren, Co. Clare in the west of Ireland (ITM 525628 706989) (Figure 1). The cave occurs on the western flank of the mountain (166m OD) within a typical karst landscape that characterises much of the Burren (Figure 2). Located close to a natural pass between Moneen Mountain to the north and Aillwee Mountain to the south, the cave is reached after a steady uphill walk. The mountain dominates the local landscape with expansive and panoramic views from the cave, but the cave entrance itself is inconspicuous and well hidden (Figures 3 and 4).

In June 2011, cavers digging through the floor of Moneen Cave uncovered fragments of a human skull, an antler hammerhead/macehead, pottery sherds, oyster shells and animal bones (O'Connell 2012). The National Monuments Service (NMS) and the National Museum of Ireland (NMI) were contacted and, following an archaeological assessment of the site by this author, the NMS commissioned and funded a rescue excavation of the cave. This excavation took place over two weeks in August that year, directed by M. Dowd under licence 11E0316. Combined with the material discovered by cavers, the archaeological excavations in Moneen Cave resulted in the recovery of a Neolithic flint flake; the Early Bronze Age antler hammerhead/macehead; 353 sherds of Middle/Late Bronze Age pottery representing at least six vessels; six oyster shells (at least one dated to the Middle/Late Bronze Age); the skeleton of a 14-16 year old boy who died in the 16th or 17th century AD; and a tiny quantity of charcoal. The 3,172 animal, bird and fish bones retrieved included a Neolithic bear cub femur; a Middle Bronze Age red deer antler; a Late Bronze Age rib of a large mammal with cutmarks; as well as recent faunal remains.

Though this was a short and relatively small-scale excavation, the site has produced interesting material, which contributes to broader discourses on Bronze Age ritual; prehistoric cave use; and the difficult lives lived by many impoverished people in post-medieval times. This was also the first archaeological excavation in an Irish cave carried out by a team of both archaeologists and cavers. The success of this collaboration will hopefully inspire future archaeological cave excavations to take a similar approach. The final excavation report was submitted to the National Monuments Service and the National Museum of Ireland in 2012 (Dowd 2012a). Summary accounts of the excavation have already been published (Casserly and Dowd 2011; Dowd 2012b, 2013a, 2013b), but the specific objective of this monograph is to present in detail the excavation results and scientific analyses conducted on the archaeological remains, and to broadly discuss the findings. This monograph does not, however, provide a detailed interpretative analysis of the material from the cave within wider Bronze Age or post-medieval landscapes. The book is divided into 28 sections, including 13 contributions by 17 specialists from various disciplines. Part I (Sections 1-6) provides an introduction to the site and describes the excavation; Part II (Sections 7-20) presents the specialist scientific analyses; Part III (Sections 21-27) discusses the chronological use and overall significance of the cave; and the combined reference list is in Section 28.

In this book, date ranges for the chronological periods are as follows:

Mesolithic: 8000-3900 BC
Neolithic: 3900-2400 BC
Chalcolithic: 2400-2200 BC
Early Bronze Age: 2200-1500 BC
Middle Bronze Age: 1500-1000 BC
Late Bronze Age: 1000-600 BC
Iron Age: 600 BC-AD 400
Early medieval: 400-1169 AD
Late medieval: 1169-1550 AD
Post-medieval: 1550-1800 AD

Abbreviations used:

NMI – National Museum of Ireland
NMI (NHD) – National Museum of Ireland, Natural History Division
NMS – National Monuments Service

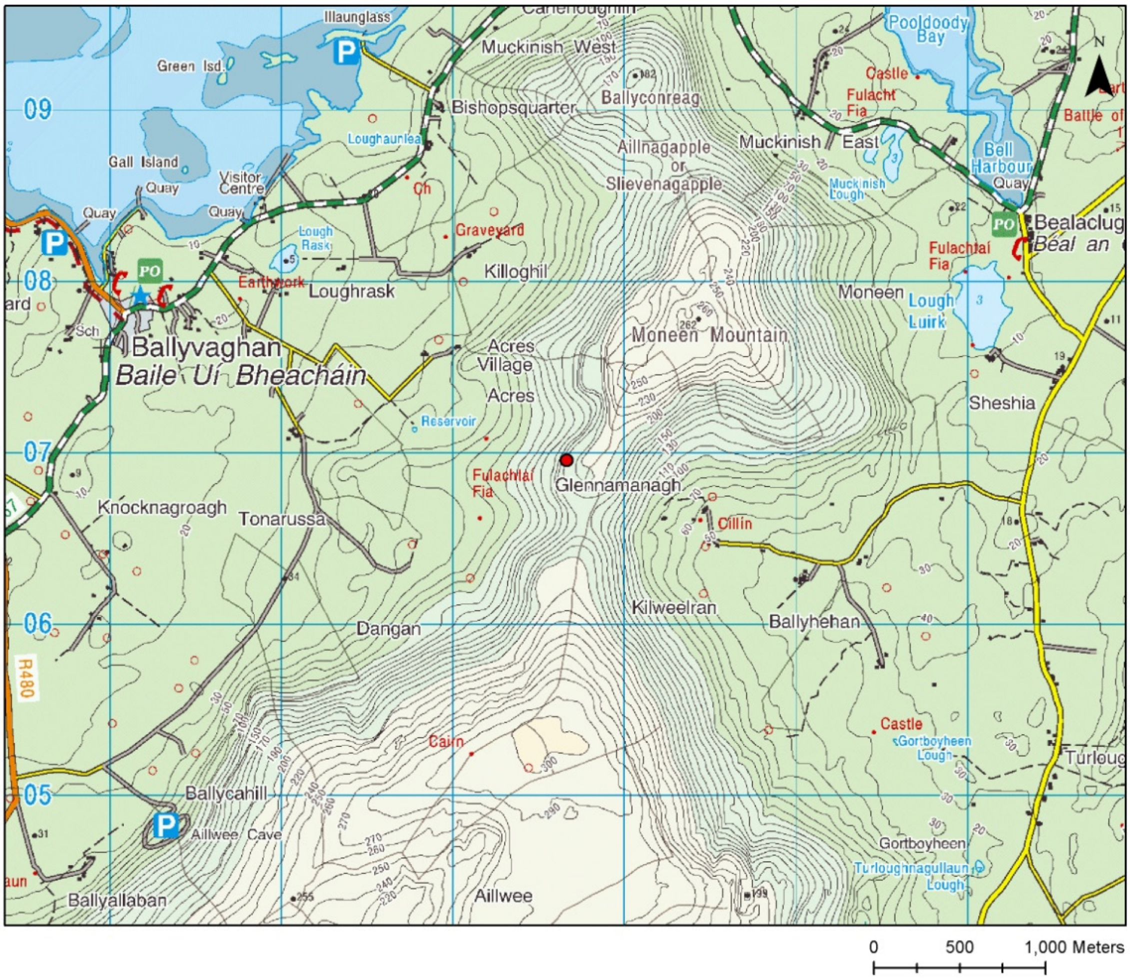

Figure 1 Location of Moneen Cave (extract from Discovery Series Maps, Sheet 51).

Figure 2 Location of Moneen Cave indicated on flanks of Moneen Mountain (Ken Williams).

Figure 3 Views from the cave entrance towards Ballyvaughan village and the sea to the west-north-west (Marion Dowd).

Figure 4 Entrance into Moneen Cave; the white caving helmet provides scale (Marion Dowd).

2. Geology and geomorphology

David Drew

The entrance to Moneen Cave is located in the lowest cliff, and 12m above the lowest terrace, on the western flank of Moneen Mountain (Figure 2). This terrace corresponds to the uppermost bed of the Maumcaha member of the Burren Formation. The cliff in which the cave is developed is located in the lowest six beds of the Lower Aillwee member of the Burren Formation. The Aillwee members are characterised by the existence of shale/mud layers, which interrupt the limestone strata at intervals. These layers of impurities correspond to the major terrace features, which occur on eastern and western facing slopes of the Ballyvaghan Valley. They also act as barriers to the vertical penetration of groundwater and are often associated with seepages and, in some instances, cave inception levels (e.g. Aillwee Cave which lies *c*. 500m to the south and at the same stratigraphic level). In contrast, the underlying Maumcaha member is massive and uniform in character and gives rise to the uniform slope that extends below the cave terrace down into the Ballyvaghan Valley. Some 55m directly below Moneen Cave are the springs that comprise a part of the water source for Ballyvaghan and the surrounding area.

The cave entrance (roof) appears to be located at the head of a short gully *c*. 2-3m in width, which breaches the cliff (Figure 4). There is no sign of bedrock in the gully, though it is apparent on either side, and large boulders occupy most of the gully. It is possible that the original cave entrance extended vertically the full 12m down to the level of the terrace. The cave comprises an inclined rift, oriented north to south in the main fracture system, and descending for at least 8m before becoming impassably blocked. The eastern face of the rift is a bedrock feature; the western (outer) wall seems to be mainly in collapsed material. The large scallops (20-40cm in diameter) on the upper part of the bedrock wall demonstrate that this is the remnant of a true karst cave which developed when completely filled with slow flowing water. The present-day cave is a fragment of an ancient cave that was developed when the landscape and the hydrology were radically different to those of today. It is not possible to determine whether the original cave was a large triangular passage (of which only one wall now remains) or an inclined rift. To the north and south of the cave, major cols eat into Moneen Mountain and their development has eroded away the continuation of Moneen Cave in both directions. Thus the cave is an ancient relict fragment, presently acting only to conduit local rainwater recharge vertically downwards.

The following geological observations are relevant to an archaeological understanding of the cave:

- It is likely that the lower levels of the cave, beneath the main entrance chamber, have been sealed for a long period. Moonmilk (a bacterially decomposed surface layer of limestone), *circa* 50mm in thickness, is present in abundance on the main chamber walls above the archaeological strata but scarce below, indicating that the lower zone has been cut-off from the exterior atmosphere for a significant time – possibly since the postglacial period.
- The limestone rubble in the cave is anomalous as the roof that overhangs much of the chamber has not experienced any breakdown, and the scree-like rubble could not have entered the cave horizontally. Some of the stones in the cave seem to be imported and may originate from the area of the gully outside where natural weathered rubble of various sizes occurs.
- The 'niche' at the northern end of the cave appears to be of artificial origin. Its walls and roof show no signs of having been worked by water; moonmilk is present as on the natural cave walls (i.e. it is of recent origin in geological terms). On the right (south) side of the niche a joint provided the line of weakness for quarrying, but no such line of weakness is apparent on the left (north) side. It is difficult to envisage how natural processes could have created this space. Immediately to the right (south) of the niche, it may be that an attempt at quarrying a similar void using joint-weakened rock was initiated but either failed or was abandoned.
- The lack of glacial material in the cave suggests that the chamber was not open to the outside during the last ice advance (ice covered the Burren from about 28,000 to 15,000 years ago). It seems the chamber was subsequently breached, perhaps by natural weathering of the cliff face.

3. History of investigation

The existence of a cave on the northwestern slopes of Moneen Mountain has been known to the landowner, Mr Gerard Collins (pers. comm.), for at least the past 40 years. As children, he and others used to throw stones gathered from the exposed limestone surface outside, into the cave through the present entrance opening. Mr Collins also remembers going into the cave as a child. The cave has always been known to his family as *the Hole in John Davoren's Wall* because the entrance lies just a few metres from a stone wall that demarcates not only the boundary between Collins' field and the adjacent property (owned by Mr Davoren), but also the boundary between Acres townland and Dangan townland.

Despite local knowledge, the cave is not indicated on any editions of the Ordnance Survey maps and its existence was not known to either archaeologists or the caving community prior to 2010 (Figures 5-8). The cave is not, for example, catalogued in the major works on caves in Co. Clare by Tratman (1969), Self (1980) or Mullan (2003). In September 2010, the cave entrance was noticed by hill walker Tony McFadden who subsequently mentioned it to Terry Casserly – a member of the *Clare Caving Club* and Conservation Officer with the *Speleological Union of Ireland* (Terry lives at the foot of Moneen Mountain). The cave was noted in an update of new cave discoveries in Clare and Galway and named 'Moneen Cave' (Boycott *et al*. 2011, 242). That name is retained here simply because the site has been published as such, and also because the older name for the cave (*the Hole in John Davoren's Wall*) was not known to cavers or archaeologists until the 2011 excavations were almost complete.

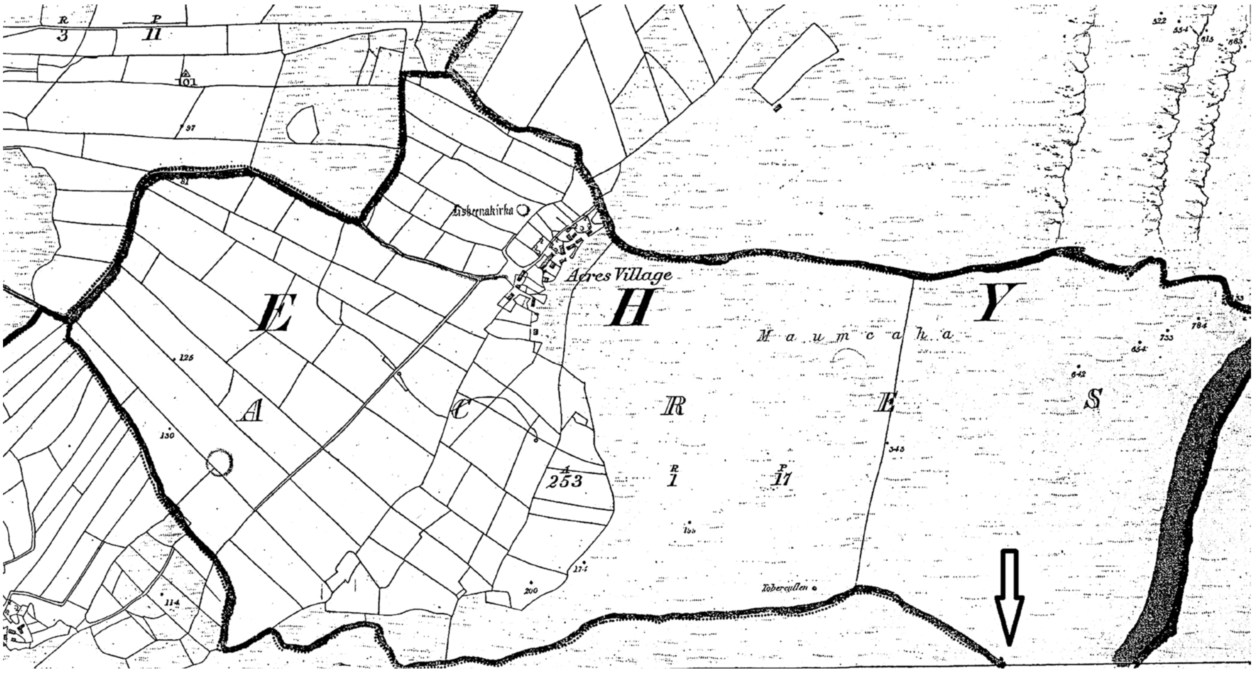

Figure 5 Ordnance Survey 1st edition map, Clare sheet 2 (surveyed 1840, published 1842). Location of cave indicated to bottom right, but not marked on original map.

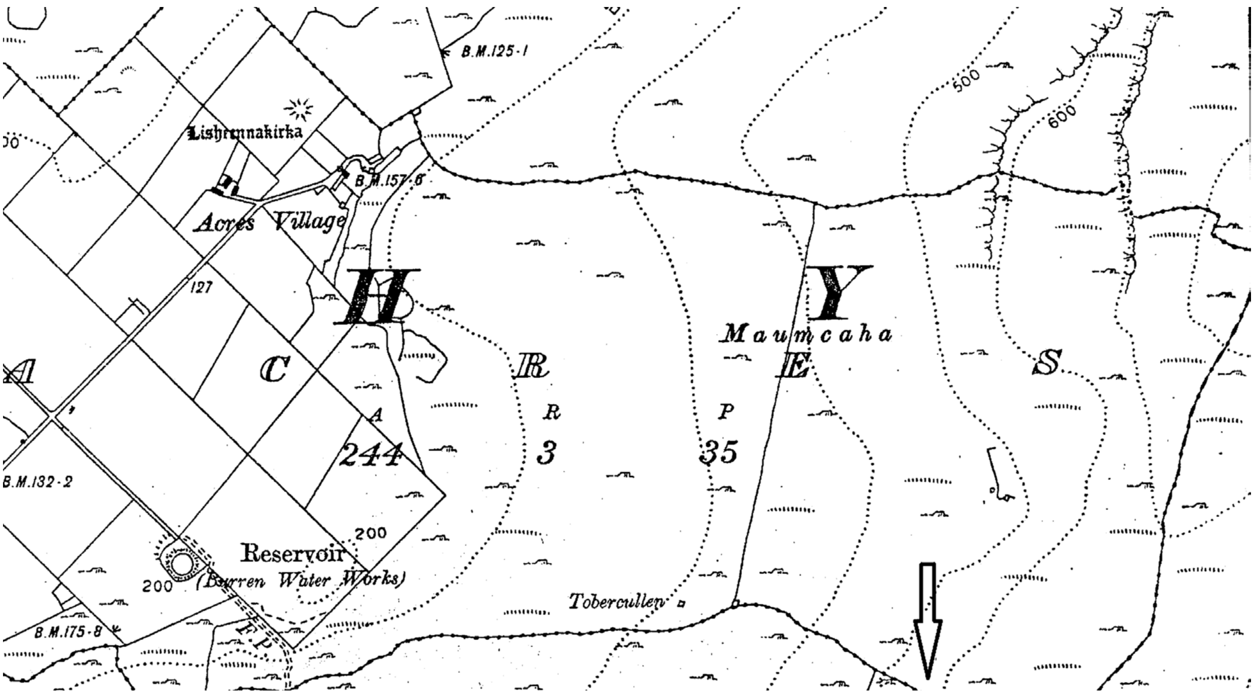

Figure 6 Ordnance Survey 2nd edition map, Clare sheet 2 (surveyed 1894/5, published 1899). Location of cave indicated to bottom right, but not marked on original map.

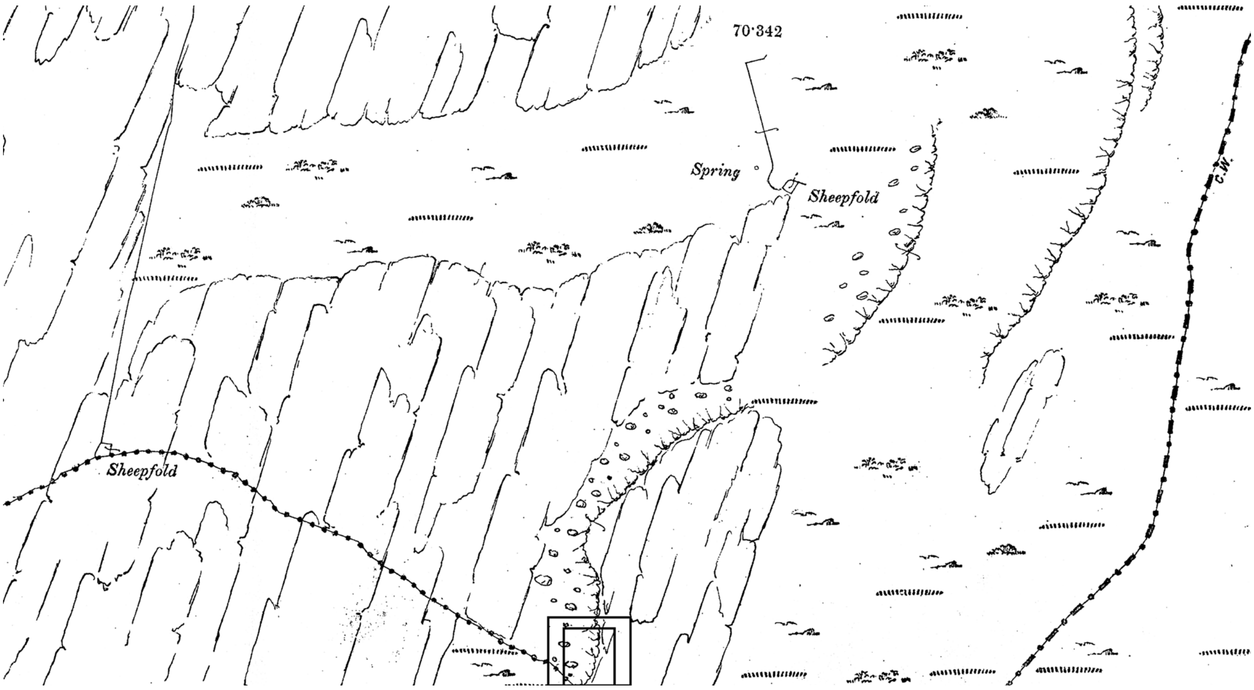

Figure 7 Ordnance Survey 1:2500 map, Clare sheet 2 (surveyed 1894, published 1897). Location of cave indicated to bottom centre, but not marked on original map.

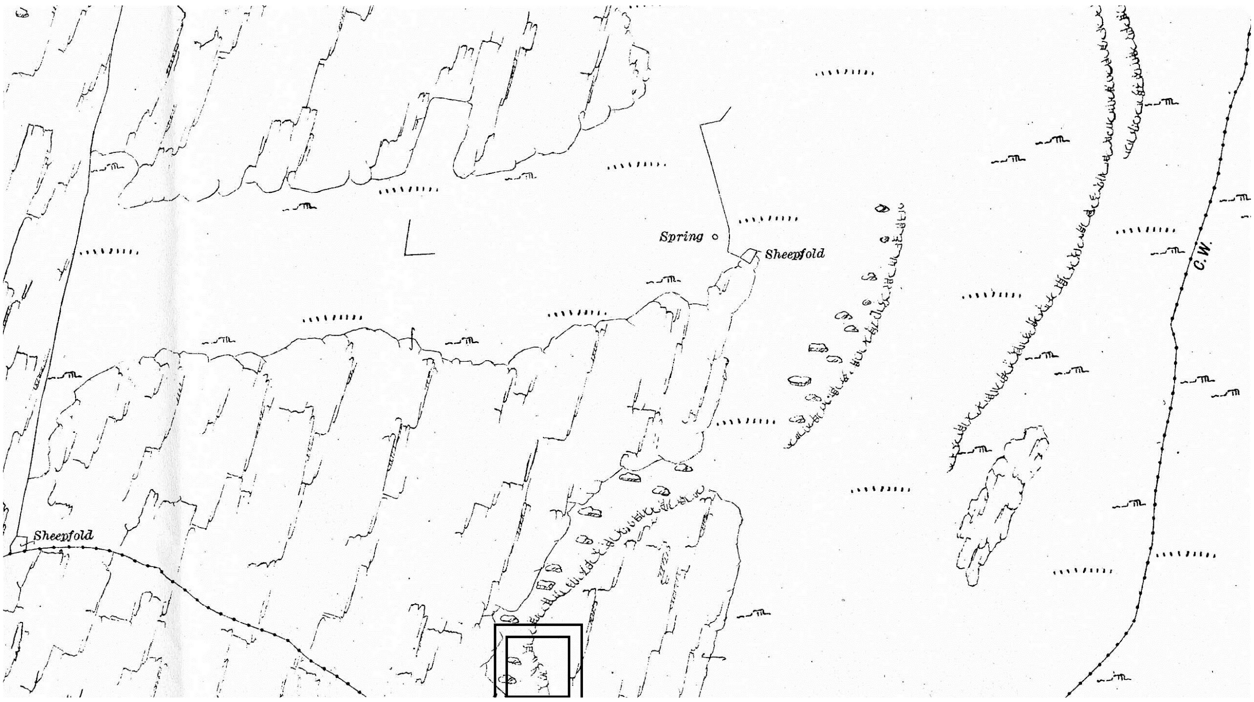

Figure 8 Ordnance Survey 1:2500 map, Clare sheet 2 (surveyed 1913, published 1914). Location of cave indicated to bottom centre, but not marked on original map.

On the 14th June 2011, cavers Quentin Cowper, Tim O'Connell and Gaelen Elliffe commenced digging through the floor of Moneen Cave in an attempt to push the known length of cave passage and establish whether a more extensive cave system existed. This involved removing limestone rubble and digging a descending vertical passage through the south-eastern area of the chamber floor. In the process, archaeological material was inadvertently disturbed and exposed. This included human skull fragments; an antler hammerhead/macehead; 28 pottery sherds; three oyster shells; and 16 animal bones (two cattle; five sheep/goat; six large mammal; two medium mammal; one unidentifiable) (Figures 9 and 10). On recognising the archaeological nature of the material, the team immediately ceased digging.

Cavers Terry Casserly and Danny Burke were subsequently contacted; they in turn respectively informed the author and Christine Grant of the NMS. On the 15th June, Grant visited the site to carry out a preliminary inspection and subsequently allocated a Sites and Monuments Record number to the cave: CL002-080----, and CL002-080001- to the skeleton.

On 23rd June, I inspected the cave and compiled an archaeological assessment, which was submitted to the NMS recommending an archaeological survey and rescue excavation. The NMS commissioned the excavation, which I directed. The two main objectives were:

1. to recover archaeological artefacts and deposits that lay exposed in the cave and were vulnerable to damage or destruction;
2. to establish the date and nature of archaeological activities at the site.

The excavation took place over two weeks from the 15th to the 26th of August 2011 inclusive, with a team of four archaeologists (M. Dowd, E. Lynch, M. Lynch and C. Lynch) and three cavers (T. Casserly, Q. Cowper and T. O'Connell). This was the first archaeological cave excavation in Ireland where the team comprised both archaeologists and cavers – something that had previously been mooted as the most desirable scenario for archaeological excavations in caves (Dowd *et al*. 2011: 39).

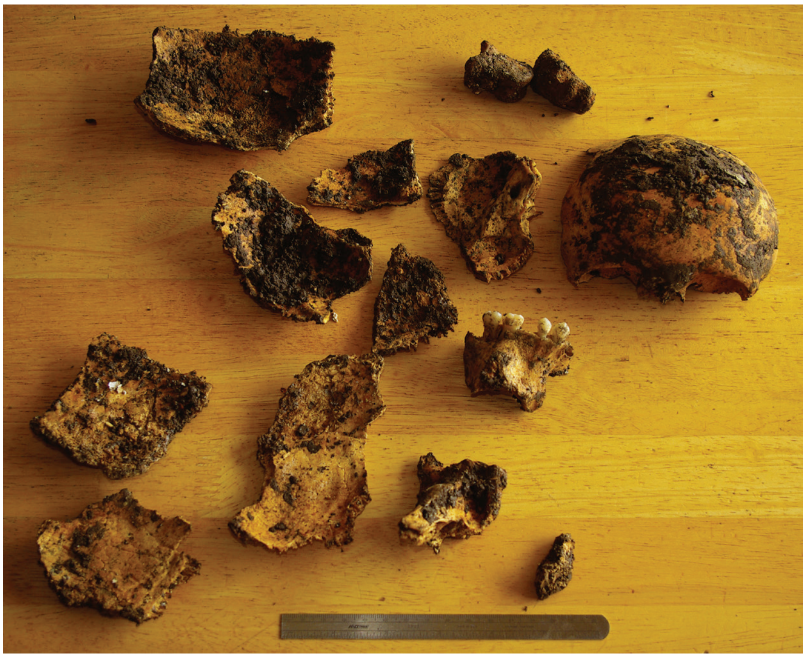

Figure 9 Human skull fragments discovered by cavers in Moneen Cave, 11th June 2011 (Danny Burke).

4. Cave morphology

The entrance to Moneen Cave consists of a small irregular opening in the cave roof above the western wall of the cave chamber (Figures 4, 11, 12 and 13). Originally it measured about 0.35m x 0.30m, but some rocks were removed in June 2011 to facilitate access thus increasing the size to 0.60m x 0.30m (Terry Casserly pers. comm.). It is possible that the entrance was blocked in antiquity following the last usage of the site (i.e. in post-medieval times). If this was the case, it could have been blocked from the inside *or* from the outside (a factor that is relevant to the interpretation of the adolescent skeleton of 16th/17th century date).

Figure 10 Sherds of Late Bronze Age pottery and Early Bronze Age antler hammerhead/macehead discovered by cavers in Moneen Cave, 11th June 2011 (Danny Burke).

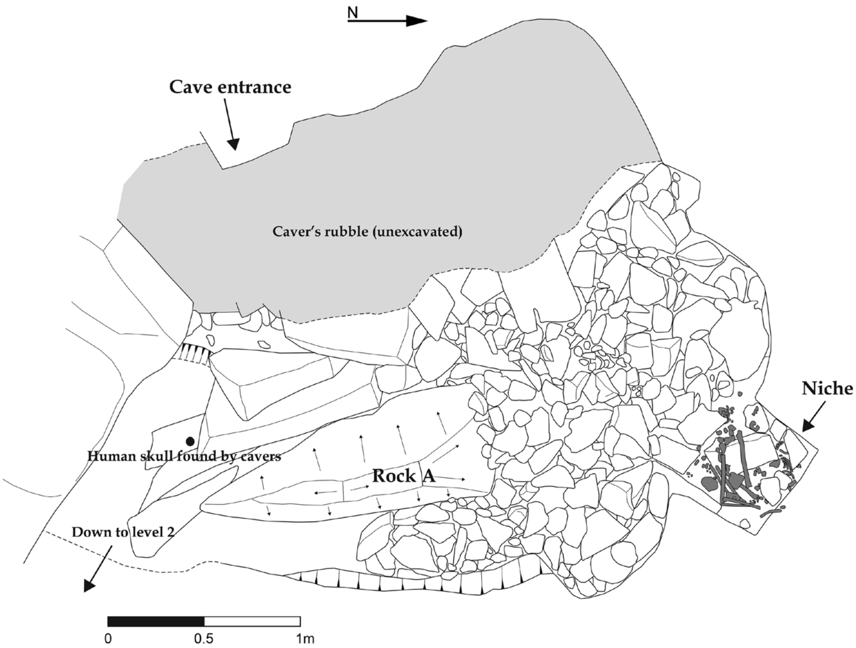

Figure 11 Post-excavation plan of Moneen Cave.

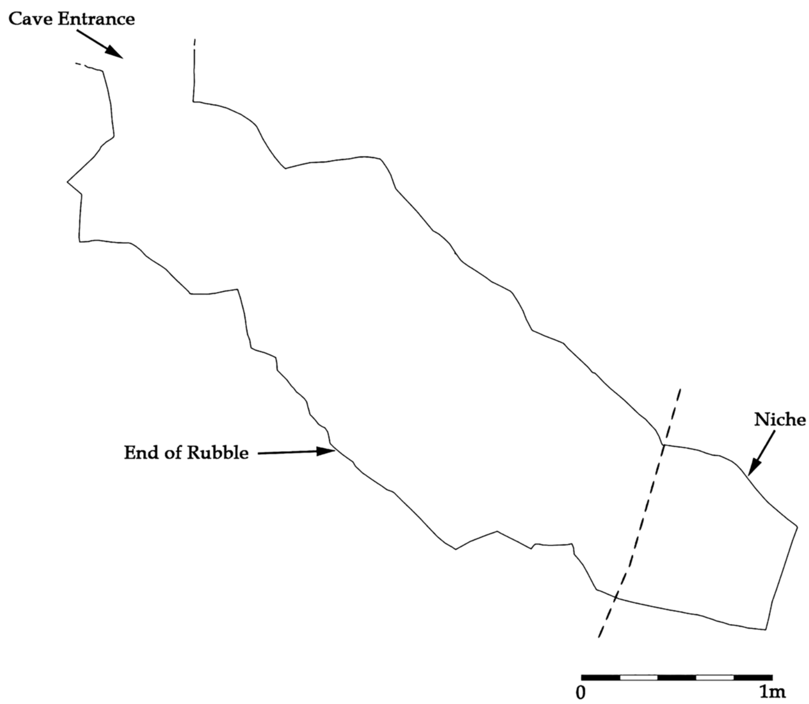

Figure 12 Longitudinal profile from cave entrance to niche in main chamber.

There is a vertical drop of approximately 2m from the entrance to the cave floor beneath (Figures 11, 12 and 13). The cave consists of a small, irregular, roughly oval limestone chamber that measures 3.4m north-south and ranges from 2.3m to 3m east-west. It reaches a maximum height of 1.8m, though for the most part it is not possible to stand upright. The floor of the chamber was largely covered in limestone rubble. A large flat boulder (Rock B) is located beneath the cave entrance. Crawling over this boulder permits a tight squeeze into deeper levels of the cave. The eastern part of the chamber is dominated by another large prominent boulder (Rock A) that is set on its long axis, aligned north-south (Figure 14). It measures 1.6m north-south, reaches a maximum width of 0.57m at the northern end, and stands 1.43m above the level of the cave floor. A concentration of archaeological material and relatively undisturbed strata were found abutting the eastern and northern sides of Rock A suggesting it was a significant feature when the cave was used in prehistory. It is not possible to determine whether it naturally occurred in an upright position, or whether it was levered into place.

A small regular rectangular niche extends from the northern wall of the cave chamber and measures between 0.60m and 0.76m east-west (width), 0.60m north-south (depth), and varies in height from 0.75m to 0.88m. The side walls are covered in calcium carbonate (cauliflower formation) and lichen. It is difficult to ascertain whether it is a natural or artificial feature, though Drew (Section 2) believes it is artificial, and that is also my opinion as it is too regular in shape to be natural. If it is in fact artificial, natural fissures in the limestone may have been exploited to cleave off blocks of stone thereby creating the recess. The post-medieval skeleton was contained within the niche but does not necessarily date the feature, though the bones clearly provide a *terminus ante quem*. The niche could, for instance, relate to Bronze Age activities and was later reused in post-medieval times.

Prior to June 2011 it was only possible to squeeze into the deeper levels of Moneen Cave by crawling over Rock B underneath the entrance. As the horizontal potential of the cave seemed promising, cavers began digging through rubble and blasting occasional rocks in the south-eastern part of the chamber thereby creating an artificial descending passage which then provided a second route into deeper levels. This passage was dug

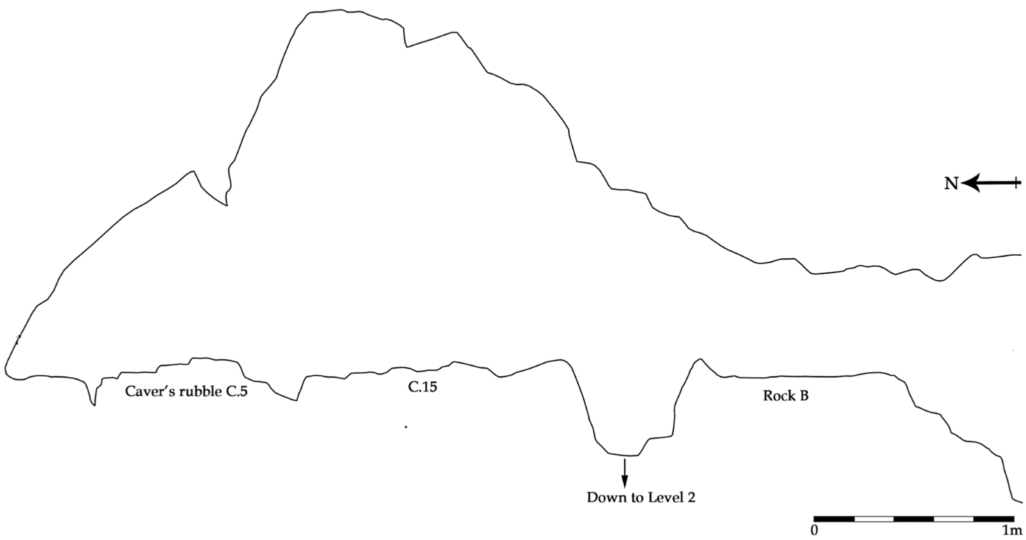

Figure 13 Profile through main cave chamber.

through a mass of rubble and was relatively unstable. During the archaeological excavation the cave chamber was called Level 1 and the passage dug out by cavers became Level 2. The end of this passage forked and provided two potential areas for further caver digging – Level 4 to the west and Level 3 to the east. Level 4 was a small void within the rubble that was large enough to crouch inside and contained some pottery and bones that had percolated down from overhead levels. Cavers concluded that Level 4 was unlikely to provide any further access into deeper levels. Level 3 appeared to be more promising though it became choked after a few metres and was quite unstable; it was too dangerous for exploration from an archaeological perspective and was not pursued. Pottery and bones had again percolated down from upper levels in the cave and were visible on the floor of Level 3.

5. Excavation and post-excavation methodology

The archaeological excavation commenced at the deepest level of the cave (Levels 3 and 4), and progressed upwards through Level 2 until the chamber (Level 1) was reached. All the archaeological material and animal bones in Levels 2, 3 and 4, i.e. beneath the cave chamber, had percolated down in antiquity or in the recent past via a variety of natural and cultural formation processes and was therefore *ex situ*. The cave chamber was the only part of the cave where *in situ* archaeological strata were encountered, though stratification was also disturbed here.

All deposits in Moneen Cave were excavated by hand and recorded using the single-context system. Sediments removed from the cave were washed on-site through 3mm mesh sieves using water sourced from a nearby spring. Artefacts, bones, charcoal, ecofacts and modern finds were extracted by hand, bagged and labelled on-site. By 100% wet sieving of all excavated deposits, even the tiniest bones and artefacts were retrieved.

The human skeleton that was discovered in a niche in the north wall of the cave chamber was not in a formal burial position. The skeleton was planned (scale 1:10) and extensively photographed. Each bone was bagged and given an individual number that was then marked onto the plan. In this way the precise location of skeletal elements and individual bones were recorded, allowing for future reconstruction of the spatial arrangement of the skeleton as encountered during excavation.

The stratum (C.20) in which the skeleton occurred was entirely bulk sampled, removed from site, and wet sieved under laboratory conditions at IT Sligo; artefacts and ecofacts were extracted from the flots. All the human and animal bones recovered during the excavation were washed at IT Sligo and left to air-dry before re-bagging (Figure 15).

6. Stratigraphic report

Few undisturbed contexts were encountered during archaeological excavations in Moneen Cave, as this was a rescue excavation focussed on removing vulnerable material and deposits that were under threat of further disturbance. At no point were deposits removed to bedrock level and therefore intact strata and archaeological material remain in the cave. A full list of contexts appears in Appendix 1. Appendix 2 consists of the list of finds. Animal bones by context are listed in Appendix 3, and Appendix 4 provides a list of the human bones based on their location within the niche and cave chamber. Those contexts that could be related stratigraphically are presented in Figure 16. Artefacts and bones that were recovered by cavers prior to the archaeological excavations were given the context

Figure 14 Rock A, an upright boulder, which dominated the cave chamber. Niche is in darkness to left (Ken Williams).

Figure 15 Washed animal bones air-drying in the archaeology laboratory at IT Sligo (Marion Dowd).

number: C.0X. Moneen Cave continues to be an 'active' environment with gradual and occasional slippage of rocks and stones. Consequently, material – namely bones and pottery sherds – have occasionally become exposed since the completion of archaeological excavations and have been recovered by cavers. These finds have been allocated the context number: C.XX.

Cave chamber: Level 1
(C.4, C.5, C.15, C.16, C.18, C.19, C.20, C.21, C.22)

Six contexts (**C.4**, **C.5**, **C.15**, **C.16**, **C.18**, **C.19**) were recorded in the main cave chamber with an additional three contexts (**C.20**, **C.21**, **C.22**) confined to the niche in the north wall of the cave. The relationship between eight contexts is summarised in Figure 16; **C.4** is not included as it could not be tied into the sequence due to disturbance by caver activities.

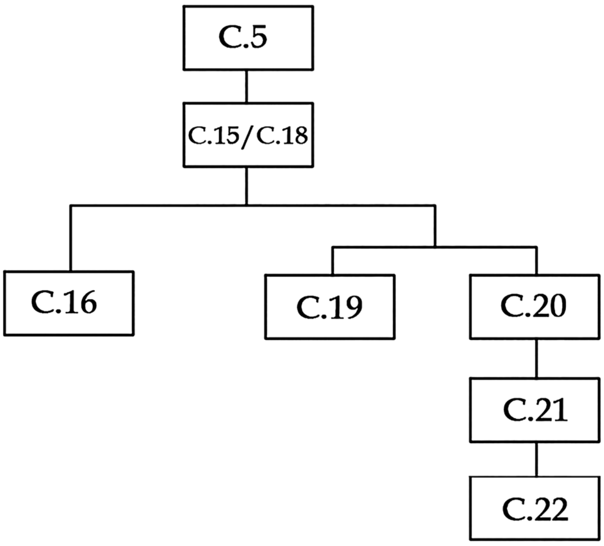

Figure 16 Harris matrix of site.

One of the lowest strata encountered in the main chamber was **C.19**, a seemingly undisturbed *in situ* deposit to the west and south of Rock A and abutting it. **C.19** was a firm greyish brown silty clay with inclusions of angular stones, snail shells and a single fragment of charcoal. Retrieved from this context were 20 sherds of Bronze Age pottery (vessels 2, 3 and 6), including some of the largest and most intact sherds recovered during the excavation and, in particular, a large rim fragment (Figures 17 and 18). **C.19** also produced 110 animal bones including 2 sheep/goat, 1 red deer antler fragment radiocarbon dated to the Middle Bronze Age, 5 hare/lagomorph, 2 mouse, 9 bones of various sized mammals, 4 chicken bones, and 84 unidentifiable bone fragments. All the evidence suggests **C.19** is principally a Bronze Age stratum, though with some intrusive material, namely the chicken bones. It was sealed by **C.18** and **C.15** (Figure 19). To the west of Rock A was another relatively undisturbed and *in situ* stratum (**C.16**) (Figure 20). This was a stony layer set in a firm mid-brown silty clay (60% stone, 40% sediment) with frequent snail shells and occasional charcoal flecks. The southern part of **C.16** had a high sediment content, whereas the northern part was stonier and sediment had percolated down into deeper levels through gaps and hollows amongst the stones. **C.16** produced one sherd of Bronze Age pottery and 33 animal bones, only three of which were identifiable and derived from a small shark or ray. Ten sherds of Bronze Age pottery (vessels 4 and 5) and three human bones of post-medieval date sat on the surface of **C.16**, at the interface with the overlying **C.15**.

At the onset of the archaeological excavations, the uppermost deposit in the southern and central part of the cave chamber was **C.15** (Figure 19). It had been exposed and disturbed by caver activities. **C.15** consisted of a layer of limestone rubble set in a firm to loose mid-brown silty clay (*c*. 60% rubble, 40% clay) with moderate inclusion of snail shells. **C.15** extended between Rock A to the east and the caver's rubble (**C.5**) to the west; the southern portion was probably displaced by caver activity. **C.15** produced a small fragment of an oyster shell as well as 86 animal bones including 1 cattle, 7 sheep/goat, 1 rat, 12 bones of various sized mammals, 2 passerine bird bones, and 63 unidentifiable bone fragments. In the northern part of the cave chamber, a similar deposit (**C.18**) occurred as the uppermost stratum but the stones here were larger than those in **C.15** (Figure 19). **C.18** consisted of a layer of limestone rubble (90% stone) set in a firm brownish grey silty clay with inclusions of calcium carbonate (Figure 20). It sealed **C.19** and **C.16**. Two sherds of Bronze Age pottery (vessel 1) and a natural sandstone stone (noted because it was the only non-limestone stone encountered during the excavation) were retrieved from **C.18**, in addition to 107 animal bones including 2 sheep/goat, 3 hare/lagomorph, 9 bones of various sized mammals, 1 passerine bird bone, and 91 unidentifiable bone fragments.

An artificial rubble deposit (**C.4**) was created by cavers when they dug through deposits in the cave to create a passageway leading down from the cave chamber into deeper levels (Level 2) (Figure 21). Minor explosives had been used by a caver to blast rock in this area and the resultant cartridges were recovered from **C.4** during the archaeological excavation. This can be considered an artificial and recent context, probably originally comprising **C.15** and/or **C.16**. **C.4** occurred beside Rock B between the cave chamber and the start of the passageway into Level 2 (Figure 22). It consisted of a rubble deposit set in loose mid-brown silty clay (60% stone, 40% soil) with occasional inclusions of small angular stones and snail shells. **C.4** produced 37 animal bones including 6 bones of medium sized mammal/s, and 31 unidentifiable bone fragments. Also recovered were an oyster shell, two fragments of charcoal, 13 sherds of Bronze Age pottery (vessels 1 and 5), and a

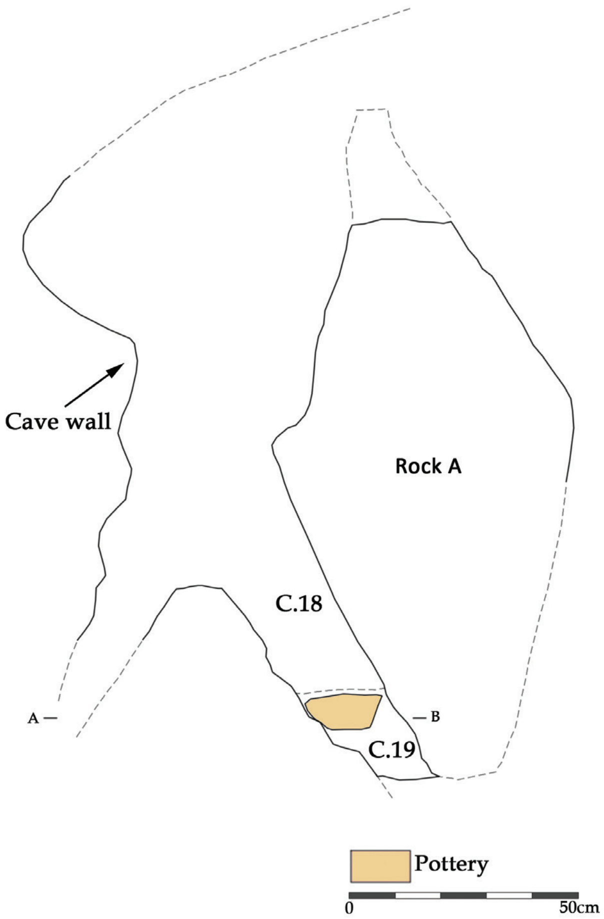

Figure 17 Profile of Rock A with C.19 indicated.

Figure 18 Large rim sherd of pottery from C.19 (Quentin Cowper).

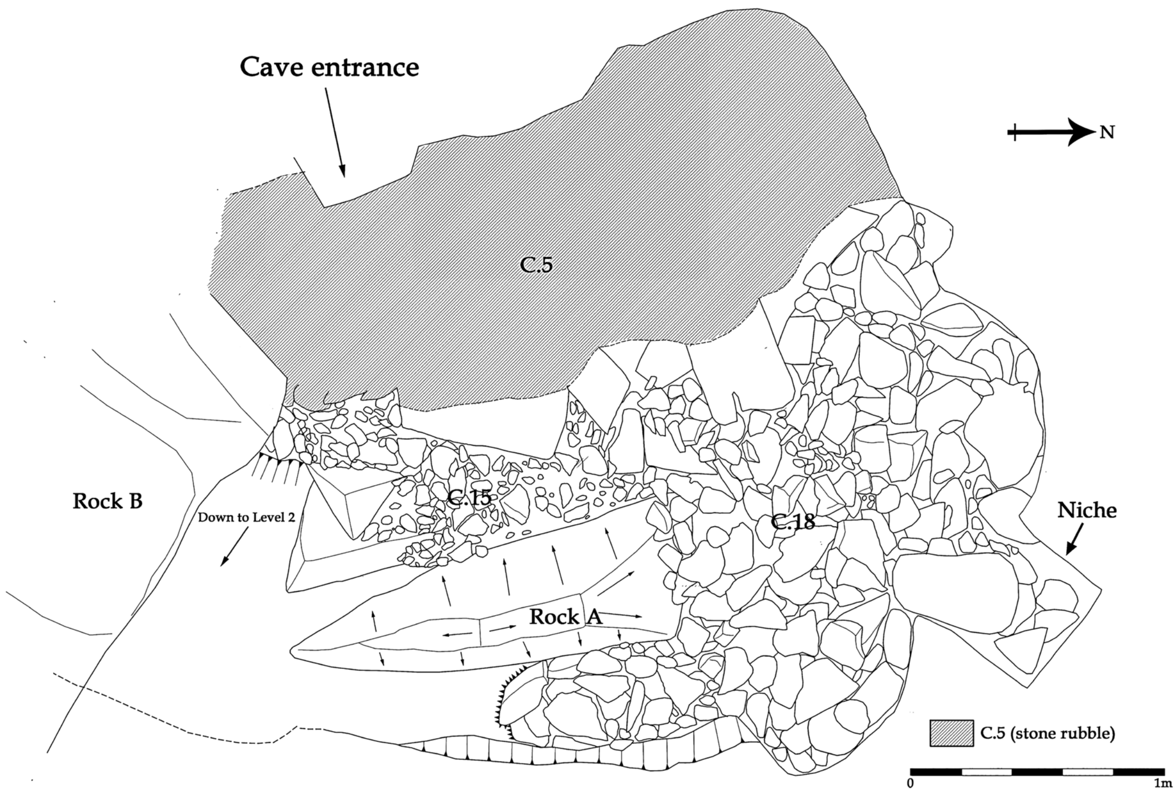

Figure 19 Pre-excavation plan of C.5, C.15 and C.18.

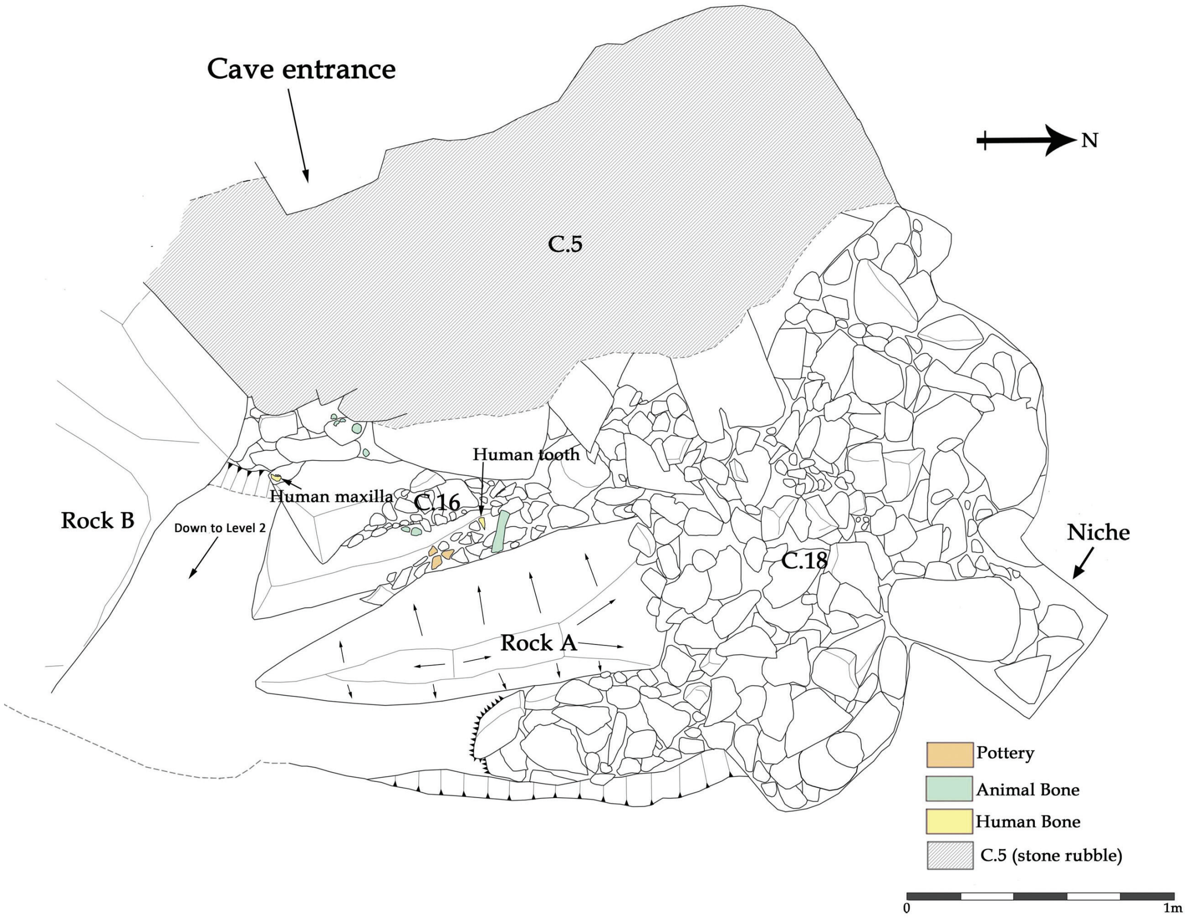

Figure 20 Pre-excavation plan of C.16 and C.18.

fragmented post-medieval human cranium and tooth. This skull belonged to the skeleton from **C.20** in the niche and the maxilla fragment that rested on **C.16** in the cave chamber. The dispersal of the skeleton through different strata and areas of the main chamber demonstrates the level of disturbance in antiquity and more recently.

Most of the digging carried out by cavers in June 2011 took place in the southern and south-eastern part of the cave chamber. It is not clear what contexts were truncated, though parts of **C.18** and **C.15** were probably removed. Some of the rubble dug up from the lower levels of the cave to create the descending passage into Level 2 was also brought up into the chamber. The resultant mixed rubble (**C.5**) created by cavers digging in various parts of the cave, and through different context, was piled to a maximum height of 1m in the western and northern parts of the main cave chamber and was also packed into the niche in the north wall (Figure 22). Only a small part of **C.5** was removed during the archaeological excavations. It consisted of limestone rubble with little or no sediment. Seven animal bones, including three of a large mammal, were retrieved from it. Most of C.5 remains piled against the western wall covering an area approximately 3.2m x 2.8m and almost certainly sealing undisturbed archaeological strata.

Niche, cave chamber: Level 1
(C.5, C.18, C.20, C.21, C.22)

It was not possible to correlate the strata encountered in the niche with deposits in the cave chamber as a natural rock lip at the opening of the niche served to separate deposits. The lowest stratum encountered in the niche was a deposit of firm brown silty clay containing lumps of calcite (**C.22**). It was exposed and lightly trowelled but not excavated. From the portion of **C.22** that was removed, 67 animal bones including 9 mouse, 9 small mammal, and 49 unidentifiable bone fragments, and one piece of charcoal were recovered. A layer of breathable geo-textile membrane was placed over **C.22** and the niche was partially backfilled with stones at the end of the excavation. **C.22** had been sealed by **C.21** which comprised several stones and calcite chunks (Figure 23). Eight human foot bones had fallen down through gaps between the stones of **C.21** onto and into **C.22** but these bones derived from **C.20**. Similarly, 33 animal bones were recovered from the interface between **C.22** and **C.20** and included 1 hare/lagomorph, 2 mouse, 7 small mammal, and 23 unidentifiable bone fragments.

C.21 was sealed by **C.20** – a layer of mid-brown silt with inclusions of small stones, calcite and snail shells. This context was entirely bulk sampled and sieved in

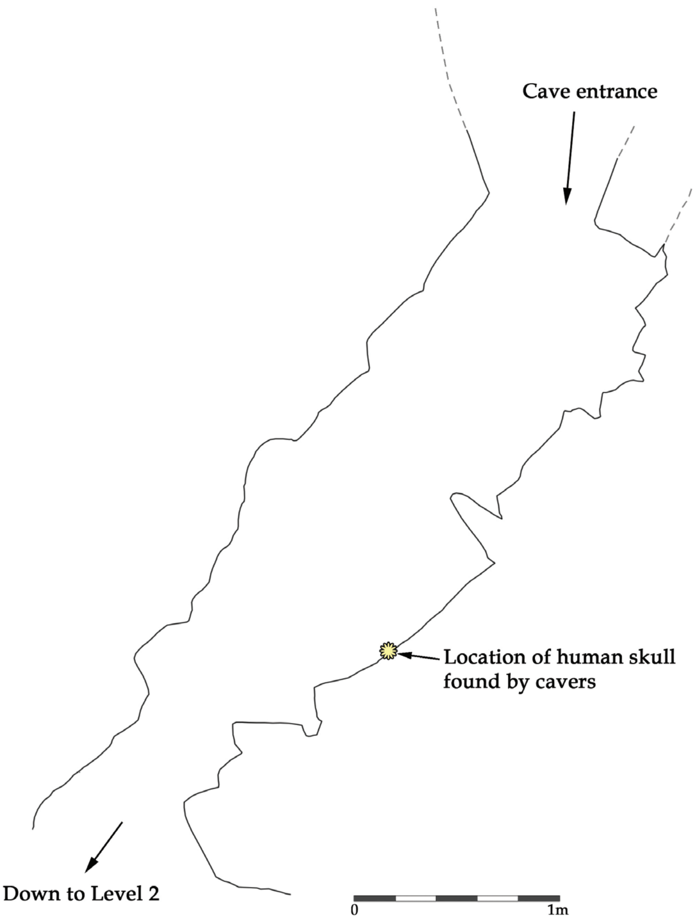

Figure 21 Vertical profile through cave from entrance in cave roof, through cave floor (Level 1), and into artificial passage (Level 2) created by cavers.

laboratory conditions at IT Sligo. It produced 162 animal bones including sheep/goat, 2 mouse, 1 frog, 36 bones of various sized mammals (mainly very small mammals), 1 passerine bird bone, and 121 unidentifiable bone fragments. Tiny flecks of charcoal were also recovered. The post-cranial part of the post-medieval human skeleton rested on the surface of **C.20** but many of the smaller skeletal elements had worked their way into **C.20** and the underlying **C.22**. Apart from the absence of the cranium, the skeleton was relatively *in situ* as tiny skeletal elements were recovered confirming this was the original location of the fleshed corpse. However, within the niche the bones had been quite disturbed and were not in correct anatomical position (Figures 24). The skeleton was sealed by a layer of limestone rubble (**C.18)** which occurred elsewhere in the cave chamber but this rubble layer in the niche may not be contemporaneous with the formation of **C.18** in the chamber as rock may have tumbled into the niche at a later date (Figure 25). Overlying **C.18** was a layer of rubble (**C.5**) dumped by cavers into the niche when digging into deeper levels. In fact, at the onset of the archaeological excavations, the niche was not visible as it was completely filled with **C.5**. The archaeological remains in the niche had not, however, been disturbed by caver activities.

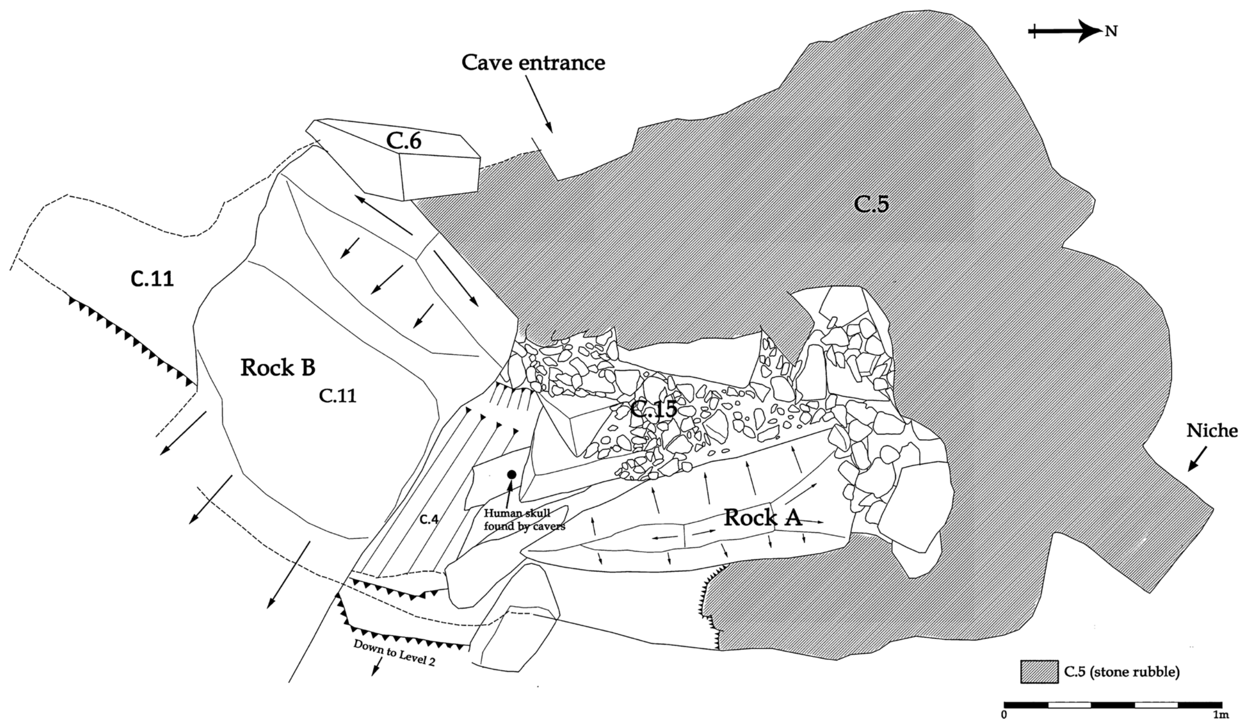

Figure 22 Pre-excavation plan of C.4, C.5, C.6, C.11 and C.15.

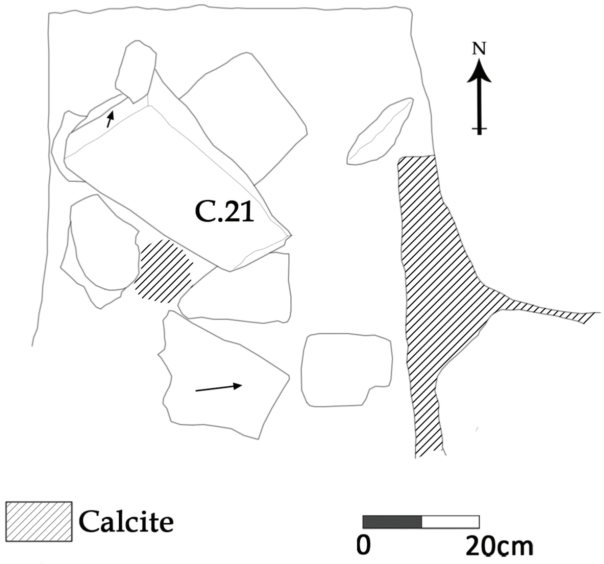

Figure 23 Pre-excavation plan of C.21 in niche.

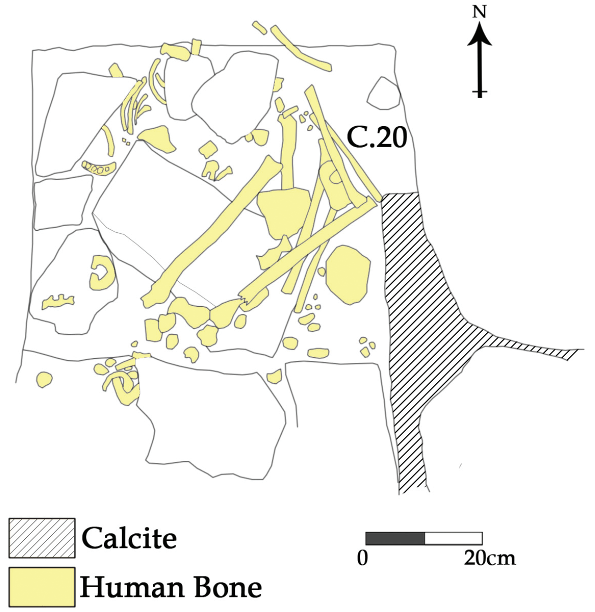

Figure 24 Pre-excavation plan of human skeleton in niche on C.20.

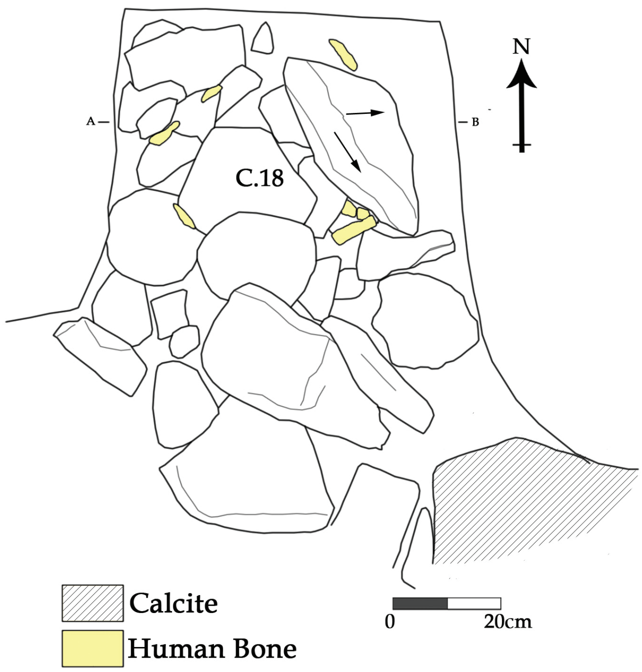

Figure 25 Pre-excavation plan of niche with human bones visible through C.18.

Descending passage between cave chamber and deeper levels: Level 2
(C.1, C.3, C.13)

When cavers dug through the floor of the cave chamber in June 2011 they created a descending passageway (Level 2) that slopes down from the cave chamber (Figures 21 and 26). The antler hammerhead/macehead was discovered midway along this passage by cavers (Tim O'Connell and Quentin Cowper pers. comm.) and had probably fallen down from the cave chamber overhead. This passageway is entirely artificial and did not exist in prehistory or in recent centuries.

The lowest stratum encountered during archaeological excavations in the passageway (Level 2) was a rubble layer that was not excavated. It was exposed, cleaned and covered with a layer of breathable geo-textile membrane, which was in turn covered with rubble at the close of excavations. **C.13** was the lowermost deposit excavated, but was only removed from the lower (eastern) end of the passage. **C.13** consisted of a firm yellowish brown clay with occasional stone and calcite flecks. It contained one piece of charcoal, crumbs and one sherd of Bronze Age pottery (vessel 1), a small fragment of oyster shell, and 64 animal bones including 2 sheep/goat, 3 hare/ lagomorph, 1 rat, 15 bones of various sized mammals, and 43 unidentifiable bone fragments.

Overlying **C.13** was **C.3**. This layer probably represents soil that percolated down from the cave chamber (Level 1) in antiquity, or at least prior to any modern activities in the cave. **C.3** was only removed from the lower (eastern) part of the passage. It comprised a firm mid-brown silty clay with occasional inclusions of stones, moderate snail shells and flecks of charcoal and calcite. It contained four sherds of Bronze Age pottery (vessels 1 and 5) and a broken flint flake. This context produced 381 animal bones including 2 cattle, 4 sheep/goat, 23 hare/ lagomorph, 10 mouse, 2 foetal animal bones, 28 bones of various sized mammals, 1 duck bone, 10 passerine bird bones, and 300 unidentifiable bone fragments.

A deposit of greyish brown silty clay (**C.1**) was the uppermost stratum in the descending passage and overlay **C.3**. **C.1** consisted of a loose greyish brown silty clay with calcite flecks and moderate inclusions of large and small stones (Figure 26). It appeared to have fallen down from the main cave chamber and may also include slippage from **C.7**. **C.1** was disturbed and quite trampled

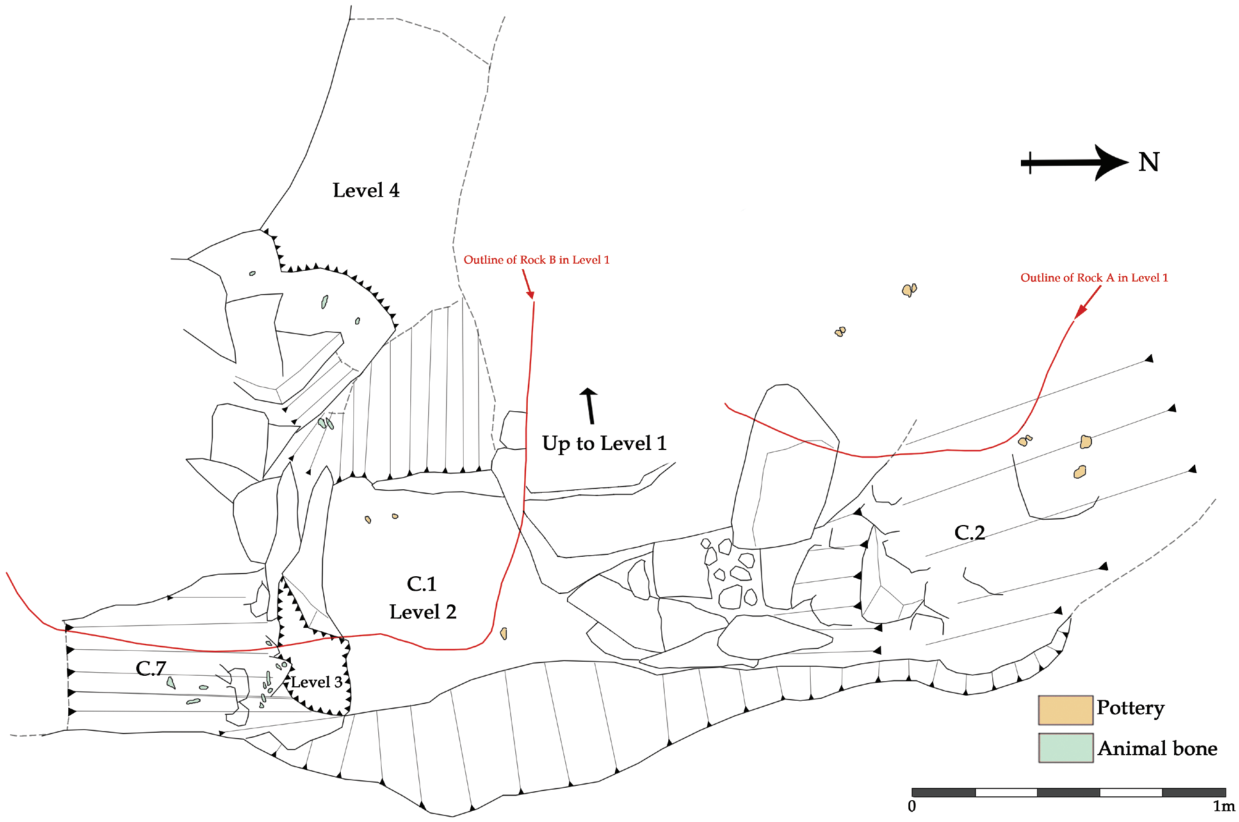

Figure 26 Lower levels 2, 3 and 4 in relation to the main cave chamber, with post-excavation plan of C.1, C.2 and C.7.

by people travelling deeper into the cave, as evidenced by the fact it produced a modern 10c coin along with 42 sherds and crumbs of Bronze Age pottery (vessels 1, 2, 4, 5 and 6) and one oyster shell. A total of 701 animal bones were recovered including 12 sheep/goat, 1 Early Bronze Age pig pelvis, 1 hare/lagomorph, 1 mouse, 1 frog, 9 foetal animal bones, 76 bones of various sized mammals (including one cattle rib with cutmarks), 3 bird bones (passerine), and 597 unidentifiable bone fragments. **C.1** was only removed from the lower (eastern) section of the passage. Part of this context remains undisturbed in the upper (western) part of the passage abutting the cave chamber, and possibly also at deeper levels south of the passage.

Isolated deposits including* ex situ *and modern material: Levels 1, 3 and 4
(C.6, C.7, C.9, C.10, C.11, C.12, C.14, C.17)

Several isolated deposits were identified within the cave that cannot be tied into the site stratigraphic matrix. These deposits have accumulated primarily by natural means, representing slippage of deposits from elsewhere in the cave, or deposits that have accumulated in relatively recent times. **C.6** consisted of a loose dark brown friable and organic silty clay. It occurred as a localised deposit on a rock above Rock B, just inside the cave entrance (Figure 22). It was of recent origin, possibly related to animal burrowing activities in the vicinity of the entrance, and seems to reflect activities outside rather than inside the cave. A fresh juvenile goat skull, 2 mammal bones and 17 unidentifiable bone fragments were collected from a natural crevice in the limestone by the cave entrance and near **C.6**. The bones appear to have been placed there in the very recent past (possibly by cavers) and are likely to represent a young goat that died outside the cave. The bones were not in a soil matrix and were bagged as **C.6**.

Another seemingly recent deposit was **C.11**, which consisted of a loose to firm mid-greyish brown silty clay that occurred as a thin spread on the surface of Rock B just inside the cave entrance (Figure 22). It produced 4 animal bones including 1 mouse, 1 small mammal and 2 unidentifiable bone fragments. Because of its proximity to the entrance, **C.11** is likely to have been introduced by natural formation processes from outside the cave. Originally, cavers gained access to the deeper levels of the cave by squeezing over Rock B and **C.11** and, in the process, **C.11** was almost certainly disturbed and dragged deeper into the cave. Thus some of the isolated deposits encountered in Levels 3 or 4 may represent a portion of **C.11** that had fallen inwards, or had been inadvertently dragged in by cavers. For instance, **C.12** was very similar to **C.11** and occurred to the south of, and beneath, Rock B. **C.12** may have come from outside the cave and is possibly the result of animal burrowing activities that were identified on the ground surface overhead. **C.12** comprised a loose mid-brown silty clay with occasional angular stones and pebbles, and a small quantity of charcoal. Cavers would also have crawled over this context when accessing deeper levels of the cave prior to the creation of the artificial descending passage (Level 2). **C.12** produced 173 animal bones including 1 cattle, 1 sheep/goat, 1 hare/lagomorph, 1 mouse, 1 frog, 21 bones of various sized mammals, 2 corncrake, 1 duck, 2 passerine bird, and 142 unidentifiable bone fragments.

Other isolated deposits – **C.7**, **C.9** and **C.10 –** deeper in the cave may represent portions of **C.12** and/or **C.11** that had spilled down from the vicinity of Rock B. These deposits occurred in random pockets amongst rocks and limestone rubble, and in all cases seemed to be of natural and recent origin. **C.7** consisted of a vertical spill of loose and crumbly mid-greyish brown rich silty clay that rested on the edge of limestone rubble (Figure 26). It occurred above the opening into Level 3. **C.7** contained occasional to moderate inclusions of calcite flecks, small stones and pebbles, frequent snail shells and a few fragments of charcoal. It was particularly dense in animal bones and produced 1 cattle, 54 sheep/goat, 2 mouse, 1 rat, 1 frog, 372 bones of various sized mammals, 2 corncrake, 1 rook/crow, 1 duck, and 158 unidentifiable bone fragments.

C.9 was located in Level 3, one of the two areas opened up by cavers in an attempt to access deeper levels of the cave (Figure 26). **C.9** consisted of a loose mid-brown silty clay with frequent inclusions of small angular stones and pebbles. This deposit probably represents part of **C.7** that had fallen downwards, but **C.9** also included a mix of deposits (including archaeological strata) from the artificial cave passage (Level 2) that had been dislodged and dragged into Level 3 by caver activities. An oyster shell and 38 animal bones were recovered from **C.9** including 7 sheep/goat, 27 bones of various sized mammals, and 4 unidentifiable bone fragments. Included in this was the rib of a large mammal of Late Bronze Age date that bore skinning marks. **C.14** consisted of a portion of **C.9**, possibly intermixed with **C.7**, which was knocked into Level 3 during the archaeological excavation. It produced 134 animal bones including 5 sheep/goat, 1 bat, 46 bones of various sized mammals, and 82 unidentifiable bone fragments. A crumb of Bronze Age pottery was also recovered.

In the second artificial cavity (Level 4) created by cavers digging at the base of the Level 2 passage, an *ex situ* deposit (**C.10**) was recovered from the floor of this small rectangular void (Figure 26). **C.10** appeared to be a mix of deposits that had percolated downwards from upper levels, probably including part of **C.12**. **C.10** consisted of large and medium-sized stones within a matrix of loose greyish brown silty clay (70% stone, 30% clay). **C.10** contained small fragments of charcoal and 11 sherds of Bronze Age pottery (vessels 1 and 5). Also recovered from this deposit were 354 animal bones including 1 Neolithic bear cub femur, 33 sheep/goat, 6 hare/lagomorphs, 1 cat, 1 mouse, 54 bones of various sized mammals, 1 duck, 10 passerine bird (some fragmented), 4 unidentifiable bird, and 241 unidentifiable bone fragments.

Isolated pockets of Bronze Age pottery
(C.2 and C.8)

Two isolated pockets of Bronze Age pottery (**C.2**, **C.8**) were identified in lower levels of the cave. These had percolated down from the cave chamber in antiquity and were exposed and vulnerable to destruction. **C.2** consisted of 29 sherds and crumbs of Bronze Age pottery (vessels 1, 5 and 6) spread over an area 1.2m x 0.8m amongst gaps in the limestone rubble, between the cave chamber and the start of the Level 2 descending passage (Figure 26). Three small unidentifiable animal bones were also recovered from **C.2**. A second cluster of three sherds of pottery (**C.8**) (vessels 5 and 6) was found amongst stone rubble, on a ledge and wedged between stones. These occurred beneath Rock B and above the opening into Level 4.

Part II
Excavation results and specialist analyses

7. Radiocarbon dates

Caves are notoriously difficult archaeological environments in terms of stratigraphic and contextual integrity, and are generally susceptible to a greater variety of natural and cultural formation processes than other archaeological site types or monuments. The primary consequence of this is that dating by association is unwise, and radiocarbon dating is essential to understand the complexity and nature of past activities in subterranean spaces (Dowd 2015: chapter 3). In terms of Moneen Cave, only the pottery could be dated securely following specialist analysis (Section 14). The dates of the animal bones, charcoal and oyster shells were unknown. The antler hammerhead/macehead was comparable to Neolithic and Bronze Age examples in Britain and so could be broadly dated. The partially crouched human skeleton, occurring in close spatial proximity to the Bronze Age pottery and with skull fragments occurring in the same context as pottery sherds, was reasonably assumed to be late prehistoric in date at the time of excavation. The AMS dates proved this not to be the case, once again highlighting how essential radiocarbon dating is when assessing cave deposits.

Eight radiocarbon dates were obtained from a range of material found in different areas and contexts in the cave. The results revealed activities spanning the Neolithic through to the post-medieval period (Figure 27). When considered together with the artefacts, at least four and probably five phases of activities are identifiable. The juvenile bear femur is of Neolithic date and possibly contemporaneous with the broken flint flake. An Early Bronze Age horizon is represented by the antler hammerhead/macehead and the pig pelvis. There then appears to be a gap of several centuries with human activities at the cave again resuming towards the end of the Middle Bronze Age in the form of the unmodified antler fragment. The pottery indicates activities at the interface between the Middle and Late Bronze Age, but the butchered cattle rib and oyster shells are significantly later and attest to a Late Bronze Age presence. The range of dates largely testifies to intermittent use of Moneen Cave by individuals throughout the Bronze Age. Subsequently, however, the site appears to have been largely abandoned or forgotten about for approximately two and a half millennia. In fact, the post-medieval skeleton is the only sign of human activities at the cave in historic periods. The human pre-molar from C.20 in the niche had insuffcent protein levels which meant that the late medieval date was questionable (Stephen Hoper pers. comm.). Consequently, a second bone, a metatarsal from the same context and area, was submitted for dating. This returned a slightly later date than that of the tooth and suggests that the

Material	Lab code	Date BP	$\delta^{13}C$	$\delta^{15}C$	C:N	Calibrated date (2σ)
Bear cub right femur Juvenile < 3mth C.10, Level 4	UBA-27259	4373±38	-20.7	5.6	3.29	3091-2907 cal BC
Antler hammerhead/macehead C.0X, Level 2	UBA-20291	3645±46	-22.71	2.10	3.60	2139-1895 cal BC
Pig pelvis C.1, Level 2	UBA-20319	3455±40	-21.51	5.69	3.27	1888-1669 cal BC
Unmodified antler fragment C.19, Level 1	UBA-19932	2970±38	-21.78	1.66	3.36	1368-1359 cal BC 0.009 1314-1053 cal BC 0.991
Oyster shell C.1, Level 2	UBA-20292	3113±28	0.5	---	---	1041-783 cal BC 1.000 *
Large mammal rib with butchery marks C.9, Level 3	UBA-19276	2744±30	-21.53	3.19	3.25	973-957 cal BC 0.040 939-818 cal BC 0.960
Human 2nd mandibular right pre-molar Bone 125 in niche C.20, Level 1	UBA-19275**	407±26	-20.8	---	---	1436-1516 cal AD 0.901 1596-1618 cal AD 0.099
Human 1st left metatarsal Bone 113 in niche C.20, Level 1	UBA-19933	265±24	-21.01	7.91	3.34	1522-1573 cal AD 0.272 1628-1667 cal AD 0.659 1782-1797 cal AD 0.069

* marine reservoir correction applied
** an incorrect lab code for this sample was given in Dowd (2013a: 11)

Figure 27 Radiocarbon dates from Moneen Cave.

skeleton dates to the post-medieval period. In this book the post-medieval period is considered from AD 1550 – in accordance with the Irish Post-Medieval Archaeology Group (IPMAG) recommendations (Horning *et al*. 2007). That said, there is a slight possibility that the remains relate to the last few decades of the late medieval period. For ease of reference, the individual is referred to throughout as post-medieval, though the slightly earlier date cannot be discounted.

8. Mammalian faunal remains

Fiona Beglane

The mammalian faunal remains from Moneen Cave were identified using comparative collections and with reference to Hillson (1992) and Schmid (1972). The number of identified specimens (NISP) was calculated for each species based on these identifications, with fragments that were evidently from the same bone combined as a count of one. All fragments above *c*. 5mm in size were counted, as were identifiable small bones and fragments under this size. The minimum number of individuals (MNI) was calculated where appropriate, taking into account the side of the body but not states of fusion, sizes of bones or toothwear.

Sheep and goat bones were separated where possible using Boessneck (1969), Kratochvil (1969) and Payne (1969, 1985). Rabbits and hares were separated on the basis of size and cranial differences by comparison with reference material. Fusion data was based on Silver (1963), Schmid (1972: table IX) and Reitz and Wing (1999: 76). For cattle and pigs, toothwear was recorded as per Grant (1982) and Higham (1967) after Silver (1963). Toothwear in sheep was examined using the method described by Payne (1973, 1987).

Measurements were carried out to an accuracy of 0.1mm as per von den Driesch (1976), Boessneck (1969), Payne and Bull (1988: fig. 1), Payne (1973: 296) and Davis (1992: fig. 2). Evidence for chopping, cutting and sawing were recorded, as was gnawing by carnivores and rodents. Burnt material was classified as singed for bone with only partial blackening; burnt for blackened bones; or calcinated for those bones that were predominantly white/blue-grey in colour. For non-identifiable fragments, these aspects were only recorded when obvious on a cursory inspection. Where pathologies, developmental defects and non-metric traits were identified, these were examined and recorded in further detail.

Throughout the text the common names for species have been used. Large mammal (LM), medium mammal (MM), small mammal (SM) and very small mammal/bird (VSMB) have been used where species could not be definitely confirmed. In an Irish context, large mammals include cattle, horse and large deer; medium mammals include sheep/goat, pig, large dog and small deer; small mammals include species such as hare, fox and cat; while very small mammals include mouse, rat and bat.

Species present

The Moneen Cave assemblage contained a total of 3,126 fragments of bone (Appendix 3; Figure 28). Of these, 988 mammal and frog bone fragments were identifiable to a greater or lesser extent. This included 353 very small cranial fragments in a single bag, which were probably from a single individual in the LM or MM category, however as this could not be confirmed, calculations have been made with and without these. Excluding these cranial fragments, there were 635 identifiable fragments. Sieving and processing of the soil samples were instrumental in the retrieval of significant quantities of small bones from the larger animals and of bones from a range of small animals such as birds, fish, frog, cat, rat and the remains of a foetal/neonatal animal.

Overall, 62% of the recovered bones came from sieving or from soil samples; however, being small and often fragmentary, these were less likely to be identified, with only 51% of identified elements coming from these samples. Sheep/goat were the most commonly occurring species, with a large number of elements from medium mammals also probably deriving from sheep/goat. Hare and indeterminate lagomorph was the next most common group, and mouse remains were also present in considerable numbers. Frog, rat, cat, pig, bear and deer were represented in small numbers. Cattle were notably poorly represented, with only six elements confirmed for this species; however, it is likely that the majority if not all of the LM bones were also cattle. These mostly consisted of rib fragments, with four vertebral fragments and four long bone fragments. The bird and fish bones are the subject of a separate study (Section 10).

Butchery

Three large and one medium mammal rib bones had cut marks (Figure 29). One each came from C.1 and C.9 and two were found by cavers prior to the archaeological excavation. While much of the faunal assemblage from Moneen Cave probably represents natural occurrences, these four bones at least are definite evidence of human involvement in the dismemberment of animals. Cut marks are usually caused during filleting to remove meat but can also be created during skinning, though this would not be applicable to marks on the medial side of the bone as on some of the Moneen examples, since this side is internal to the body.

The rib from C.1 had one cut mark on the medial side and three cut marks on the lateral side. All were at right angles to the direction of the rib, in a cranio-caudal direction. While classified as coming from a large mammal, this bone was relatively small and so could potentially come from a larger medium mammal. ZooMS analysis identified this rib as cattle (Section 9). The large mammal rib from C.9 was a large rib with four cut marks on the medial side of the bone, running diagonally across the bone. This was radiocarbon dated to the Late Bronze Age (Section 7).

Bone	Cattle	Sheep/ Goat	Pig	Red deer	Hare/ Lago	Cat	Bear	Mouse	Rat	Bat	Frog	Foetus/ Neonate	LM	LM/ MM	MM	SM	VSMB
Horn/Antler		2		1													
Skull		5			1									367		1	1
Mandible		4						7									
Loose mand. tooth	2	21				1			1								
Loose tooth		2			9			19									1
Loose max. tooth	1	1															
Atlas VC1		1															
Axis VC2		1															
Scapula	1	1										2			2		2
Humerus		2			1			2			1	2			3		1
Radius		5								1		1					
Ulna		3			2			1								1	
Metacarpal	1	6															
Pelvis		1	1		3			1			1	1	1		3	2	
Femur		2			2		1		1		1				2		
Patella		1															
Tibia	1	6			4			1			1				1		1
Calcaneus		4							1								
Astragalus		4			2												
Metatarsal		8			3												
Metapodials		4			2										1	4	
Phalanx 1		13			6										1	4	3
Phalanx 2	1	13			5										1	3	
Phalanx 3		5			3										1	1	
Phalanx indet.															1		
Carpals/tarsals/ses		24													7	1	
Rib													44		96	8	22
Vertebra													4		74	10	21
Long bones indet.												5	4		19	17	4
Sternum															1		
Hyoid															4		
Total (988 specimens)	7	139	1	1	43	1	1	31	3	1	4	11	53	367	217	52	56

Figure 28 Species distribution.

Figure 29 Butchered mammal bones from Moneen Cave. From top to bottom: 7207 (C.9); 7206 (C.1); 7208 (C.0X); 9784 (C.0X) (Thorsten Kahlert).

Of the two ribs found by cavers, one was a large mammal rib with seven cut marks on the lateral side, running essentially at right angles to the direction of the rib in a cranio-caudal direction. This bone also had one cut mark on the medial side, running diagonally across the bone. One end had been broken very evenly. However, due to modern damage it was not possible to establish whether the bone had been chopped through or if this was a natural break. This bone was also partially encrusted in calcite, suggesting that it had lain exposed in the cave for some time. Again, though classified as coming from a large mammal, this bone was relatively small, and so could potentially come from a larger medium mammal. The second bone found by cavers was a medium mammal rib bone with three deep cut marks on the lateral side of the bone, running diagonally across the direction of the bone.

Species represented at Moneen Cave

Cattle (Bos sp.)

Cattle was represented by at least one individual, with loose teeth, a scapula or shoulder blade, a metacarpal (a bone in the fore foot), a tibia and a phalanx (toe bone) present. In addition, it is likely that the majority if not all of the large mammal bones were also from cattle. These mostly consisted of rib fragments, with four vertebral fragments and four long bone fragments. A cattle metacarpal from C.15 had been gnawed by a carnivore.

Sheep and goat (Ovis/Capra)

There were 139 sheep/goat elements in the assemblage and, based on the number of loose teeth, at least three individuals were present (Figure 30). Measurements are shown in Figure 31. Goats and sheep are common in the Burren so that the presence of both in the Moneen assemblage was not unexpected. Sheep was represented by 21 elements; goat by 6 elements; and 112 elements could not be further distinguished beyond sheep/goat. A juvenile goat skull was recovered from C.6; this was technically classified as four elements although it was intact. The skull was markedly fresh, with a creamy white texture and evidence of green mould or moss growth. In addition, a juvenile mandibular dP3 tooth from C.1 and a juvenile metapodial from C.15 were also identified. These could all potentially have come from the same individual.

Tooth eruption and wear data was limited; however, three mandibles, representing at least two individuals, were identified as being aged 1-2 years old (Figure 32). Both fused and unfused bones were recovered though all the late fusing bones were unfused, suggesting that only young and juvenile animals aged under 15-24 months were present (Figure 33). A number of metapodials that were unfused at the proximal end, and some of which were unfused medio-laterally, represent the remains of at least one foetal or neonatal lamb/kid. It is possible that the lamb or kid entered the cave via natural processes, or that the carcass of a miscarried or stillborn lamb/kid was disposed of in the cave.

Pig (Sus sp.)

Pig was represented by a single pelvic bone from C.1, though some of the medium mammal bones could also potentially be from this species. This element was radiocarbon dated to the Early Bronze Age (Section 7). Measurements are shown in Figure 31.

Red deer (Cervus elaphus)

A single red deer antler fragment was recovered from C.19. This was the proximal end of the antler and included the burr, demonstrating that it had been naturally shed and not recovered from a dead deer. The fragment also included part of the beam and the broken-off stumps of the brow and bez tines. There were no signs of modification of the piece

Element	Sheep/Goat			Hare/Lagomorph		
	L	R	U	L	R	U
Horn/antler	1	1				
Skull	2	2		1		
Mandible	1	2				
Loose mand. tooth			21*			
Loose tooth			2			9
Loose max. tooth			1			
Atlas VC1			1			
Axis VC2			1			
Scapula		1				
Humerus proximal	1					
Humerus distal	2			1		
Radius proximal		1				
Radius distal	2	2				
Ulna	1	1		1		
Metacarpal 1 proximal	2	1	2			
Metacarpal 1 distal	1	1	1			
Metacarpal 3 proximal						
Metacarpal 3 distal						
Metacarpal 4 proximal						
Metacarpal 4 distal						
Metacarpal U proximal						
Metacarpal U distal						
Pelvis, acet at ilium				2*	1	
Pelvis, acet at ischium		1		2*	1	
Femur proximal		2			1	
Femur distal		1			1	
Patella			1			
Tibia proximal		1		1	1	
Tibia distal	2	1		2*	1	
Calcaneus proximal		2				
Calcaneus distal	1	2				
Astragalus		2	2	2*		
Metatarsal 1 proximal	1	1	1			
Metatarsal 1 distal	1	1	3			
Metatarsal 2 proximal					1	
Metatarsal 2 distal					1	
Metatarsal 3 proximal					1	
Metatarsal 3 distal					1	
Metatarsal 4 proximal						
Metatarsal 4 distal						
Metatarsal 5 proximal					1	
Metatarsal 5 distal						
Metatarsal U proximal						
Metatarsal U distal						
Metapodial U proximal						1
Metapodial U distal			4			1
Phalanx 1			9			6
Phalanx 2			13			5
Phalanx 3			5			3
MNI	3			2		

FIGURE 30 MNI VALUES (SHOWN WITH *) AND BREAKDOWN OF SKELETAL ELEMENTS.

Context	Species	Element	Side	GL	GLl	Bp	Bd	BT	HTC	DL	Ddl/m	Dtl/m	GLP	LA/ LAR
C.7	Sheep	Astragalus	R		31.7		21.0			17.6				
C.15	Sheep/Goat	Astragalus	U		28.2		18.6			14.0				
C.1	Sheep	Humerus	L					26.6	12.6					
C.3	Sheep/Goat	Metacarpal	L			25.2								
C.15	Goat	Metapodial	U								15.0	8.8		
C.1	Pig	Pelvis	L											30.5
C.1	Foetus/Neonate	Long bone	U	13.3*										
C.3	Foetus/Neonate	Radius	U	19.6*										
C.1	Foetus/Neonate	Long bone	U	19.4*										
C.1	Foetus/Neonate	Humerus	L	19.0*										
C.1	Foetus/Neonate	Humerus	R	19.0*										
C.1	Foetus/Neonate	Scapula	L										3.8*	
C.3	Foetus/Neonate	Scapula	R										3.8*	
*Unfused bone, measurement is without epiphyses														

Figure 31 Measurements.

Context	Species	Side	dP2	dP3	dP4	P4	M1	M2	M3	MWS	Age
C.00	Sheep/Goat	R	A	A	17L	C	9A	5A	C	D	1-2 years
C.14	Sheep	R	A	A	14L	-	X	2A	C	D	1-2 years
C.7	Sheep	L	A	p	14L	-	8A	2A	C	D	1-2 years

Figure 32 Mandible ageing data for sheep/goat.

Skeletal element	Age at fusion (months)	Fused	Unfused
Metapodium proximal	Prenatal	4	3
Humerus distal	3-10	2	0
Radius proximal	3-10	1	0
Scapula	6-8	1	0
Pelvis acet at ischium	6-10	1	0
Phalanx 1 and 2	6-16	13	9
Tibia distal	15-24	0	2
Metapodium distal	18-28	0	8
Calcaneus proximal	30-36	0	2
Ulna proximal	36-42	0	2
Femur proximal	30-42	0	2
Humerus proximal	36-42	0	1
Radius distal	36-42	0	4
Femur distal	36-42	0	1
Tibia proximal	36-42	0	1

Figure 33 Sheep/goat fusion data.

in the form of chop or cut marks, but the presence of the antler in the cave is almost certainly the result of human action. The fragment was eroded and was also encrusted in calcite, indicating that it had lain exposed in the cave for some time. It was radiocarbon dated to the Middle Bronze Age. An antler hammerhead or macehead was also recovered from the cave and was radiocarbon dated to the Early Bronze Age (Section 7).

Hare/lagomorph (Lepus timidus/Lagomorpha)

The remains of at least two hares/lagomorphs were amongst the assemblage (Figure 30). The term 'lagomorph' has been used for loose teeth and where it was not possible to determine species using size or other criteria. No rabbits were specifically identified while hare was definitely present and made up the majority of the identified elements.

Cat (Felis catus)

A single deciduous pre-molar from a kitten was identified in C.10. Teeth usually preserve better than bone due to the hard enamel, and the bones of young animals are particularly prone to destruction. Both wild and domestic cat have been present in Ireland, with wild cat probably becoming extinct by the Iron Age (McCormick 1999: 364).

Bear (Ursus arctos)

A single femur of a bear cub aged under three months was recovered from C.10. This was identified by Dr Ruth F. Carden. It was radiocarbon dated to the Neolithic.

Mouse (Apodemus sylvaticus/Mus musculus)

A substantial number of mouse bones were recovered, particularly loose incisor teeth and mandibles, both of which are relatively large and are therefore likely to be retained by a sieve and to be noticed during examination of sieve contents. While only four mouse elements were recovered by hand, 14 were identified during sieving and a further 13 from the processed soil samples. These probably represent natural fauna in the cave. There were also a substantial number of elements from VSMBs that could not be identified to species.

Rat (Rattus sp.)

Three rat bones were identified. The presence of a substantial number of elements from VSMBs that could not be identified to species should be taken into consideration as some may derive from rat. Rats were introduced to Ireland during the Iron Age, having first reached Britain with the Roman Occupation (Montgomery *et al*. 2014: 157).

Bat (Plecotus sp.)

A bat radius (identified by Sheila Hamilton-Dyer) was recovered from C.14. This was probably a long-eared bat. As bats are natural inhabitants of caves, this find was not unexpected.

Frog (Rana temporaria)

Four frog bones were present. Until recently, frogs were believed to have been a post-medieval introduction to Ireland (McCormick 1999: 368). Recent genetic evidence suggests that frogs survived the last Ice Age in a refugium; however, it is possible that additional frogs were introduced or naturally colonised Ireland at a later date (Teacher *et al*. 2009).

Foetus/Neonate

Eleven foetal/neonatal bones were identified from C.1 and C.3 and probably represent a single individual. Unfortunately, it was not possible to determine the species. Measurements are shown in Figure 31.

Discussion

A wide range of species were identified from Moneen Cave, but the assemblage was dominated by sheep, hare and mouse bones, with the latter two species predominantly identified from sieved samples and laboratory-processed soil samples. The evidence suggests that the majority of faunal remains were present in the cave due to natural processes, and this is particularly true for the small and very small species.

Of the radiocarbon dated bones, the bear cub femur is the earliest, dating to the Neolithic, and is probably a natural occurrence. The dated artefactual and zooarchaeological evidence indicates that the cave was used by humans in the Bronze Age, with no dated faunal evidence from later periods. The antler hammerhead/macehead and the single pig bone from the site, a pelvis, were both dated to the Early Bronze Age. In the Middle Bronze Age, a fragment of red deer antler showed no signs of working, but as with the much earlier hammerhead/macehead, this also came from a shed antler and so its presence within the cave is indicative of human activity. It is possible that this second antler fragment was originally part of an artefact or was used to provide raw material for the manufacture of other artefacts. There were three large mammal and one medium mammal rib bones with cut marks, one of which was radiocarbon dated to the Late Bronze Age. The cut marks on these are direct signs of human activity, consistent with filleting of the carcass to remove meat, although some of the butchery marks are potentially consistent with skinning. A skilled butcher will aim to leave as few marks as possible on the bone, since each mark will contribute towards blunting the tools used. It is therefore eminently possible that other bones from domesticated species found in the cave, such as cattle, sheep and pig, represent carcasses butchered without leaving marks, although a natural origin for these is also possible. Animals may have fallen into the cave or their carcasses could have been dragged there by predators; for example, one cattle metacarpal had been gnawed by a carnivore and one goat skull appeared to be relatively fresh. In the case of sheep and goats, which are common in the Burren and which graze in remote and often precipitous areas, these could easily have been incorporated into the cave sediments by natural processes.

McCormick and Murray (2007: fig. 2.4) compared the results from a number of Bronze Age excavations and showed that generally, cattle were the most commonly occurring species, followed by pig and then sheep. However, at Dún Aonghusa, off the coast of Clare and Galway (McCormick and Murray 2007: 29), and at Roughan Hill, Co. Clare (Beglane 2008), sheep/goat outnumbered cattle, and pigs were the least common of the three main domesticated species. The low proportion of pigs from those sites suggested an open rather than forested landscape. At Moneen Cave, the MNI data suggests that at least one bovine, three sheep/goat and one pig were present, thus, despite the dominance of sheep/goat bones by number, this is not reflected in the minimum number of individuals. Most body parts are represented for sheep/goat suggesting that whole carcasses were originally present. It is therefore possible or even likely that many of the sheep/goat bones came from one or two individuals that died of natural causes. The small number of overall individuals present from the domestic species makes it difficult to interpret the relative importance of these, but they are broadly consistent with findings from other sites in the region. For hare, at least two individuals were present and most body parts are represented, again suggesting full carcasses. In the absence of any evidence to the contrary, this would indicate that they are naturally-occurring deaths, either due to predators or by individuals becoming trapped in the cave. Similarly, for the smaller wild species, such as mouse, rat, bat and frog, as well as the single cat tooth, these are species that would naturally be expected to occur in a cave environment.

9. Zooarchaeology by Mass Spectrometry (ZooMS) analysis of four butchered animal bones

Keri Rowsell and Matthew Collins

Four mammal bones from Moneen Cave had evidence of butchery (Section 8) but could not be identified to species by standard zooarchaeological techniques (Figure 29). These bones were therefore sent by M. Dowd to the University of York for ZooMS analysis in an attempt to establish the species (Figure 34).

Materials

- Ammonium bicarbonate (AmBic)
- 1.5ml eppendorf tubes
- Sequencing grade trypsin
- Termination solution (5% Trifluoroacetic acid)
- C18 ZipTip® pipette tips
- α-cyano-4-hydroxycinnamic acid (matrix)
- Calibrant
- Conditioning solution (50% Acetonitrile / 0.1% Trifluoroacetic acid)
- Washing solution (0.1% TFA)

Method

The four samples were placed on separate pieces of acid-free paper, and each rubbed in one direction using separate pieces of a Staedtler Mars Plastic eraser, according to the method described in Fiddyment *et al*. (2015: 15070). The resulting waste fragments (or 'erdu', Hall 1984) were collected and placed in 1.5ml eppendorf tubes, to which 100µl of ammonium bicarbonate (AmBic) solution was added. The tubes were then incubated at 65°C for one hour, cooled to room temperature, and centrifuged for one minute. 50µl of supernatant from each sample was transferred to new eppendorf tubes, and 1µl of sequencing grade trypsin was added to each of these. The samples were then incubated overnight at 37°C. Following this, the samples were centrifuged for one minute and 1µl termination solution was added to each.

Peptides were then extracted from the sample using a similar method to that reported by Buckley *et al*. (2009: 3844); C18 ZipTip® pipette tips were prepared using 200µl of conditioning solution, followed by 200µl of washing solution. The sample was then passed over the filter, washed using a further 200µl of washing solution, and finally eluted in 50µl of conditioning solution. 1µl of each eluted solution was spotted in triplicate onto a Bruker ground steel target plate before 1µl of α-cyano-4-hydroxycinnamic acid matrix was spotted over the top and mixed with the peptide solution. The plate was then run in reflection mode on a Bruker Ultraflex III MALDI TOF/TOF mass spectrometer.

The spectra produced were analysed using mMass, an open source mass spectrometry tool. The results of this can be seen in Figure 34. Ultimately, the ZooMS analyses did not provide species information more specific than that which had been established using standard zooarchaeological techniques, except in the case of sample 7206 which was identified as cattle.

10. Bird and fish bones

Sheila Hamilton-Dyer

Taxonomic identifications of the bird and fish bones from Moneen Cave were made using the author's modern comparative collections. All fragments were identified to taxon and element where practicable. Recently broken bones were joined where possible and have been counted as single specimens. Measurements follow von den Driesch (1976) and are in millimetres unless otherwise stated.

In total, three fish and 46 bird bones were recorded (Figure 35). The three fish bones, from C.16, are vertebrae from a very small shark or ray (Figure 36). They are not perfectly preserved but there are no obvious signs of cutmarks or of digestion. The bird bones are from at least seven taxa. Three of the four bones from C.19 are probably all from the same galliform wing, and represent a small domestic fowl (chicken) as other species present in Ireland can be excluded by size and diagnostic features, particularly on the complete carpometacarpus (Kraft 1972; Tomek and Bochénski 2009). The radius and ulna are both broken and the latter has several tooth puncture marks from a

Standard zooarchaeological assignment Context details	ZooMS code	ZooMS Assignment	Date
Large mammal rib with cutmarks C.9, Level 3	7207	Cattle, sheep, red deer or fallow deer	Late Bronze Age (UB19276)
Large mammal rib with cutmarks C.1, Level 2	7206	Cattle	Unknown
Medium mammal rib with cutmarks C.0X, Level 1/2	7208	Cattle, sheep, red deer or fallow deer	Unknown
Large mammal rib with cutmarks C.0X, Level 1/2	9784	Cattle or sheep	Unknown

Figure 34 ZooMS identification results of the four butchered mammal bones from Moneen Cave.

Context	Level	NISP	Taxon	Anatomical element	Side	SHD code	%	Notes	GI in mm
1	2	1	small passerine	sternum		nm	30	robin/dunnock/whitethroat size	
1	2	2	small passerine	tarsometatarsus		pm	50	robin/dunnock/whitethroat size	
3	2	1	duck, *Anas sp.*	tarsometatarsus	R	dm	10	eg. mallard	
3	2	1	small passerine	skull		m	75	robin/dunnock/whitethroat size	
3	2	1	small passerine	premaxilla		w	95	robin/dunnock/whitethroat size, not a finch	
3	2	2	small passerine	tibiotarsus		w	100	robin/dunnock/whitethroat size	32.4
3	2	2	small passerine	ulna		w	100	robin/dunnock/whitethroat size	19.5
3	2	1	small passerine	humerus	L	w	100	robin/dunnock/whitethroat size	16.6
3	2	1	small passerine	scapula		w	100	robin/dunnock/whitethroat size	
3	2	1	small passerine	tarsometatarsus	L	dm	50	robin/dunnock/whitethroat size	
3	2	1	small passerine	ulna	L	pm	25	greenfinch size	
7	7	1	corncrake, *Crex crex*	tibiotarsus	R	pm	15		
7	7	1	corncrake, *Crex crex*	ulna	L	w	95		
7	7	1	corvid	radius	R	wp	90	no distal end but cf. rook/crow	
7	7	1	duck, *Anas sp.*	synsacrum/pelvis		w	95	probably mallard/domestic, quite large, broad, carnivore gnawed	
10	4	4	bird indeterminate	limb frag					
10	4	1	duck, *Anas sp.*	tibiotarsus	L	dm	20	mallard/domestic	
10	4	1	small passerine	skull		m	50	thrush size	
10	4	1	small passerine	premaxilla		w	75	thrush size	
10	4	1	small passerine	humerus	R	pm	75	thrush size	
10	4	1	small passerine	humerus	R	pm	25	thrush size	
10	4	1	small passerine	mandible		w	95	robin/dunnock/whitethroat size, not a finch	
10	4	1	small passerine	mandible		mt	50	robin/dunnock/whitethroat size, not a finch	
10	4	1	small passerine	ulna		dm	50	robin/dunnock/whitethroat size	
10	4	2	small passerine	vertebrae		w	95	thrush size	
10	4	1	small passerine	pelvis	L	mt	30	thrush size	
12	9	1	corncrake, *Crex crex*	tibiotarsus	L	w	95		
12	9	1	corncrake, *Crex crex*	fibula	L	w	95		
12	9	1	duck, *Anas sp.*	femur	R	pm	75	large, probably domestic? Carnivore tooth marks	
12	9	1	small passerine	ulna	L	w	95	fieldfare size	39.2
12	9	1	small passerine	femur	L	pm	50	smaller than fieldfare but larger than dunnock	
15	1	1	small passerine	tarsometatarsus	R	dm	50	immature	
15	1	1	small passerine	humerus	L	pm	50	immature	
16	1	2	elasmobranch	vertebrae		w	95	very small shark/ray	
16	1	1	elasmobranch	vertebrae		m	30	very small shark/ray	
18	1	1	small passerine	humerus	L	dm	50	greenfinch size	
19	1	1	bird indeterminate	foot claw phalanx		w	100	domestic fowl size	
19	1	1	domestic fowl (chicken)	carpometacarpus	L	w	100		38.9
19	1	1	domestic fowl (chicken)	radius	L	w	100	broken in two	64.7
19	1	1	domestic fowl (chicken)	ulna	L	w	75	broken in 3 pieces, small carnivore tooth marks proximally	
20	1	1	small passerine	femur	L	dm	50	sparrow size	
		49							
Abbreviations: w = whole, p = proximal, m = midshaft, d = distal, t = lateral									

Figure 35 Detail of bird and fish bones from Moneen Cave.

small carnivore. Duck bones of mallard/domestic size were found in C.3, C.7, C.10 and C.12. Those from C.7 and C.12 had been gnawed. Some of the bones are quite large and broad and could belong to domestic duck but it is difficult to separate bones of the domestic bird from the ancestral mallard. The last of the larger bird remains is a corvid of rook/crow size from C.7. Bones of corncrake were identified from C.7 and C.12. The tibiotarsi are from opposite sides and could be a pair. The other bird bones are all of small passerines. Some are of small size, such as robin, dunnock or whitethroat. Others are larger, such as thrush, fieldfare and similar. A few fall between these sizes but it is not possible to reliably identify any to exact species, as there are several other similar sized passerines.

None of the fish or bird bones are burnt or have cutmarks, therefore it cannot be said for certain whether any of the remains are anthropogenic, but there are some clues as to their origin. The bones of domestic fowl (chicken) from C.19 indicate that this particular deposition is likely to post-date the prehistoric finds as this bird does not appear in British sites until the Late Iron Age (Yalden and Albarella 2009) and may not have been introduced into Ireland until sometime later, only becoming frequent in Anglo-Norman assemblages (Hamilton-Dyer 2007). The similarity of bones from C.7 and C.12, including corncrake and gnawed duck bones, suggest that these deposits are related and may have resulted from relatively recent animal activities. The small passerine bones in Level 2 could be all from a single bird but those from Level 4 must be from at least two birds as they are different species. The more complete small bird remains might be of birds that took shelter and died in the cave but the majority of the other remains are more likely to have been brought there, either by animals or by human activity. This is certainly the only explanation for the bones of marine fish but whether the agent was human or animal is less easy to determine. Some of the bird bones have carnivore tooth marks, probably from animals smaller than dog or fox. Possible candidates are cat, pinemarten or stoat. On balance it would appear that the remains are from mixed sources; some could be natural mortalities in and around the cave, some were brought in by a cat or similar carnivore. The three fish vertebrae (Figure 36) could be remains of a fish brought in by a carnivore, or even voided as a scat, but it is perhaps more likely that they were deposited by human activity.

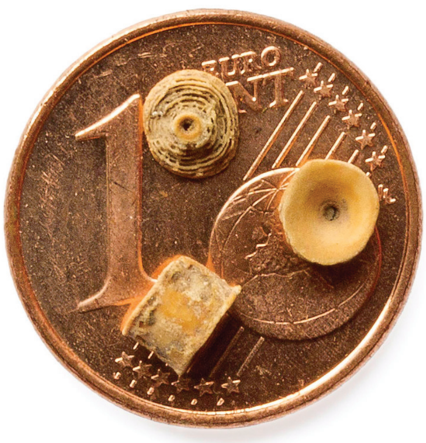

Figure 36 Three vertebrae of a very small shark or ray (Thorsten Kahlert).

11. Late Bronze Age oyster (*Ostrea edulis*) shells

Rory Connolly

Amongst the material recovered during excavations in Moneen Cave were four complete oyster (*Ostrea edulis*) shell valves, as well as a number of oyster shell fragments (Figure 37). The shells were found scattered throughout the cave in various contexts and levels. A sample obtained from one of the shells returned a Late Bronze Age radiocarbon date. The nature of the Late Bronze Age activity at Moneen Cave is not consistent with typical domestic occupation and the shells from Moneen Cave likely represent food debris or votive deposits associated with ritual activity at the site.

*Oyster (*Ostrea edulis*)*

Common or flat oysters (*Ostrea edulis*) are marine bivalves of the order Ostreoida which are widely distributed around the coasts of north-west Europe, as far south as the Iberian Peninsula and into the Mediterranean Sea (Tebble 1976: 53). They are common around Irish coasts and are recognisable by their rough, thick corrugated shell which is rounded but often irregular in shape. The outer surface of the shell is usually greyish-brown while the inner surface is pearly white with a single white adductor muscle scar (Fish and Fish 2011: 259). During life the left (lower) valves remain cemented to the substratum. Left valves are cupped and act as a container for the animal's soft tissue, while the right (upper) valves are flatter, sitting within the left to act as a lid. The valves are joined together by a ligament along the hinge line (Galtsoff 1964: 16). Flat oysters occur in beds on muddy-sands and gravels with shells, hard silts or old peat-bottoms. They thrive in the subtidal zone, but occur from low water to a depth of 82.3m (Tebble 1976: 53). Oysters have been exploited as a food source in Ireland since at least the Mesolithic (see Liversage 1968; Mitchell 1956, 1972; Woodman *et al*. 1997). As recently as the nineteenth century oyster beds were exploited for commercial shellfishing at Scattery Island, Querin and Poulnasharry along the mouth of the Shannon estuary (O'Sullivan 2001: 13). *Ostrea edulis* is naturally a member of the Irish malacofauna, however, *Crasostrea gigas* or Pacific oysters have also been commercially cultivated in Irish waters for over 40 years now

Figure 37 Oyster (*Ostrea edulis*) shells from Moneen Cave (Thorsten Kahlert).

(Browne *et al*. 2008: 8). Morphological plasticity in flat oyster shells results from the specific ecological conditions in which the population grow. Shells may become excessively distorted in packed conditions where specimens are encroaching on one another (Tebble 1976: 52). In the wild, most oysters will live to around six years although it is not uncommon for certain specimens to live longer (Fish and Fish 2011: 259).

Results

The molluscan shell material from Moneen Cave consists of four complete oyster valves, three fragmented valves that represent less than 50% of the original shell, and two small fragments that represent less than 5% (Figure 38). The combined weight of the shell material amounts to 175.33g and represents an MNI of five based on the number of right umbones present. The largest complete shell measures 10.6cm in height, the distance from the umbo to the ventral margin (after Claassen 1998: 109). This substantially sized specimen was recovered by cavers (C.0X) prior to site excavation and has been aged to between five and six years. The other complete shells measure 8.1cm (C.4), 8.2cm (C.9) and 8.5cm (C.0X) in height, and have been aged to between 3 and 4 years. Age was calculated macroscopically by counting the concentric winter growth rings visible on the shell exterior. The use of surficial growth lines for aging oysters is problematic as lines are often difficult to distinguish (Claassen 1998: 155). In addition, the shells under investigation here have undergone post-depositional deterioration in the form of surface abrasion and separation of the incremental growth lamellae. Ages are therefore offered only as an approximation and should not be taken as definitive. All complete shells represent right valves. One of the fragmented shells (C.1) also retained sufficient material to identify it as a right valve. A sample of shell from this fragment produced a radiocarbon date of 3113±28 BP (UBA-20292), calibrated at the 2 sigma range to 1041-783 cal BC, corrected for marine reservoir effect, indicating that the shell material is Late Bronze Age in date. The shells were found scattered throughout the cave in various contexts and levels. This is probably the result of site formation processes. Caves are complex archaeological environments where the integrity of stratigraphic relationships should not be assumed. It is likely that all of the shells date to the same period and in all likelihood represent a single deposition event. The location of Moneen Cave in the landscape, at 160m OD and *c*. 2.4km from the nearest shore, preclude the

Context	Level	Description	Valve	Height (cm)
0X	1/2	Complete	Right	10.6
0X	1/2	Complete	Right	8.5
0X	1/2	Fragmented		
0X	1/2	Fragmented		
1	2	Fragmented	Right	
4	5	Complete	Right	8.1
9	3	Complete	Right	8.2
13	2	Very small fragment		
15	1	Very small fragment		

Figure 38 Oyster shells from Moneen Cave by context.

possibility that the shells could have been transported by natural processes. The evidence strongly suggests that the shells relate to human activities, which took place inside the cave.

Discussion

The small quantity and fragmentary nature of the molluscan shell material limit the overall information that can be obtained from the assemblage. Given the context from that the shells were recovered, however, there are a number of points worth discussing. Archaeological assemblages that include human bones, metalwork, pottery and/or animal remains dating to the Late Bronze Age have been identified from eleven caves in Ireland. The votive deposition of these materials and objects deep inside caves was likely understood as a symbolically significant act during this period (Dowd 2015: chapter 6). The ascent up the slopes of Moneen Mountain to the cave entrance may itself have been a journey imbued with symbolic potency and a way of preparing an individual, perhaps a ritual practitioner, for activities inside the cave (Dowd 2016). The deliberate placement and arrangement of particular objects within the small chamber in Moneen Cave fits into a broader pattern of ritual cave use during the Late Bronze Age. Furthermore, the absence of features and debris typically associated with human occupation, such as hearths or habitation floors, suggest that Moneen Cave was not lived in (Dowd 2013a: 11). Archaeologists almost exclusively interpret oyster shells in archaeological contexts as subsistence refuse. This interpretation is somewhat limiting, however, as the collection, consumption and offering of food is often highly ritualised (e.g. O'Day *et al*. 2004; Russell 2015: 198). Food can play an important role in maintaining social relations and in ritual performances linked to life-cycle events and other religious activities, including feasting (Bray 2003; Dietler 2010; Dietler and Hayden 2001). Oyster shells, animal bones and broken pottery may represent ceremonial artefacts associated with feasting activities that occurred elsewhere. Their placement inside Moneen Cave may have been a way of marking a particular event. Oyster shells are not a common occurrence in Bronze Age ritual contexts in Ireland, although shells have been recovered from Bronze Age funerary contexts at Stillorgan and Palmerstown, Co. Dublin (Waddell 1990: 27). There are also some examples from earlier periods, for instance at the Neolithic cemetery in Carrowmore, Co. Sligo where a large pit of unopened oyster shells was recorded in close proximity to passage tomb 7. The excavator interpreted this unusual deposit as a ritual offering (Burenhult 1980: 32). Though limited in number, these sites support the idea that the deposition of oyster shells was sometimes perceived as a symbolically charged act.

Oysters occur on many parts of the coast around the Burren. Oyster beds are recorded around Muckinish Bay and Poulnaclough Bay *c*. 3.5km northeast of Moneen Cave. Oysters from this area were much sought after in the nineteenth century (Wakefield 1812: 124). It is possible that the oysters from Moneen Cave may have come from this area, although it is not inconceivable that they could also have been transported from the area around the mouth of the Shannon estuary or further afield. Late Bronze Age people may have dived to collect oysters, or they may have been collected on foot. O'Sullivan (2001: 131) has compared the Late Bronze Age trackway structure at Fergus estuary west 1 with similar structures on the estuaries of the Essex coast in England, which may have been associated with the exploitation of oyster beds. A common indicator of Late Bronze Age activity in coastal wetland environments where oysters may have been exploited are fulachtaí fia (O'Sullivan and Breen 2011: 80). These could potentially have been used to cook oysters. Oyster midden deposits dating to the Bronze Age have also been recorded in a number of coastal areas throughout Ireland, for instance the extensive shell middens at Ballysadare Bay, Co. Sligo (Milner and Woodman 2007).

One interesting aspect of the shell material from Moneen Cave is the prevalence of right valves. No left valves were recovered during the excavation. It is unlikely that this is the result of a preservation bias, particularly as left valves tend to be thicker and more robust than right valves, and therefore more likely to survive archaeologically. If the oysters from Moneen Cave simply represented the remains of a meal, we should expect to find left lower valves, which act as a container for the meat of the living animal and are sometimes over-represented on sites where oysters are being consumed (e.g. Le Goff and Dupont 2015). Instead, the complete absence of left valves suggests that the oyster meat was consumed at another location, perhaps a gathering site or settlement, before the right upper valves were brought to the cave. An alternative explanation is that the shells from Moneen Cave were not collected from living specimens, but instead represent beach washed shells. Right valves tend to become detached and washed ashore more frequently than left valves, which are cemented to the substratum. This raises some interesting questions. If Bronze Age people were not consuming oysters inside the cave, then what was the purpose of transporting shells several kilometres from the coast before ascending the slopes of Moneen Mountain and depositing them inside the cave? If Late Bronze Age communities perceived caves as liminal otherworldly places, then perhaps oysters, as creatures of the deep, were deemed appropriate offerings. It is interesting to note that three bones of a small shark or ray fish were also recovered from the cave (Section 10). It is not yet clear whether these are contemporary with the Late Bronze Age activities, but they hint at another link between Moneen Cave and the sea.

Conclusions

In total, four complete oyster valves were recovered from Moneen Cave, in addition to several fragments. A sample from one of the shells produced a Late Bronze Age date. Although the other shells have not been dated, it is likely that they are all contemporary and may represent a single deposition event. The nature of the Late Bronze Age activity at Moneen Cave suggests that this site was used for ritual or religious activity related to the votive deposition of symbolically charged objects and materials. The oyster shells recovered from the cave appear to fit with this interpretation. The shell material is not consistent with typical food debris associated with the consumption of oysters. The absence of left lower valves, which typically hold the meat, indicates that the oysters were consumed elsewhere. The deposition of only right upper valves may represent a form of token offering. Alternatively, it is possible that these valves did not come from living oysters, but were collected amongst beach washed shells. Late Bronze Age communities may have regarded Moneen Cave as a liminal place suitable for the enactment of certain ritual activities. The deposition of oyster shells may have been a way of demonstrating or accentuating a sense of otherworldliness, or linking the cave with a particular place or event. The small quantity and fragmentary nature of the shell material limit the information that can be obtained. Nevertheless, when considered in tandem with the other evidence from Moneen Cave, an interesting picture begins to emerge of how Late Bronze Age communities may have interacted with and understood this site.

12. Charcoal

Very small quantities of charcoal were recovered from ten contexts in Moneen Cave (Figure 39). No signs of fires or hearths were encountered during the excavations. The charcoal pieces were small and scarce and thus most likely reflect the use of torches in the cave with small pieces of a wooden torch fragmenting and falling onto the cave floor. Alternatively, the charcoal may have been inadvertently introduced into the cave with other cultural material such as the pottery or animal bones/joints of meat. Funding was not available for analysis of this small charcoal assemblage, but it has been retained in its entirety and can be accessed in the NMI for future study.

Context	Level	Description	Weight g
3	2	Charcoal	5.73
4	5	Charcoal	0.12
7	7	Charcoal	1.13
10	4	Charcoal	0.63
12	9	Charcoal	4.14
13	2	Charcoal	0.11
16	1	Charcoal	0.29
19	1	Charcoal	0.08
20	1	Charcoal	0.17
22	1	Charcoal	0.12
22	1	Charcoal	0.06
Total			**12.58g**

Figure 39 Charcoal from Moneen Cave by context.

13. Early Bronze Age antler hammerhead/macehead

Ruth F. Carden

The Early Bronze Age hammerhead or macehead from Moneen Cave was carved from a red deer antler. Evidence to date indicates that red deer were absent from Ireland during the Mesolithic period until their introduction – either through anthropogenic-mediated translocations or as late colonisers – during the Neolithic period, originating from Britain (Carden *et al*. 2012). Perforated antler objects are a relatively rare occurrence in Ireland, though with notable exceptions including the perforated antler implement from Site D at Knockadoon, Lough Gur, Co. Limerick (Ó Ríordáin 1954) and a perforated antler object from Nooan townland, Lake Inchiquin, Co. Clare – tentatively identified at the time as made from a giant deer antler (*Megaloceros giganteus*) (Liversage 1957) (Section 22).

Antler can be more easily and more rapidly worked than stone using a variety of methods (Heidelk-Schacht 1983). Hard antlers (after full growth and shedding of the velvet skin) are very hard, resistant to breakages and pressure, but simultaneously, antler possesses a degree of elasticity due to its composition, alignment of crystals and its slight curved shape. Antlers (naturally shed or otherwise) are easily transported from different sources/origins and can be considered an important trade commodity within human societies. Prehistoric peoples must have possessed knowledge of the natural regenerative cycle of deer antlers and also the behavioural ecology of the species to utilise such a natural and sustainable important resource.

The Moneen Cave object has been fashioned from the basal portion of an adult male red deer naturally shed left antler (Figure 40). The visible morphology does not indicate that this artefact has been subjected to heat: it is not stained black, has no surface fracture heat pattern, and is not decalcified or calcined. It has not been carved or decorated, but displays the natural antler surface. The pale dark brown colour is consistent with weathered hard antler. Some yellow-orange staining and greyish clay as well as calcium carbonate deposits are also visible. The coronet (or burr) is well formed but not overly thick and is not artificially polished or worked in any form. The morphology indicates this antler was shed from an adult male greater than 6.5 years of age as indicated from its dimensions (see below), i.e. prime age and older males. Veining, and pearling to a lesser degree, on the antler surface is very apparent and visible to the naked eye. The brow and bez tines (first and second tines after coronet/burr) have been removed at their respective junctions at the beam either through human-mediated means or were naturally broken off (antler breakages can occur when adult red deer stags spar and fight with one another during the mating season, in early October to mid-November).

A relatively large rounded cylindrical perforation (lateral-medial aspect, which is located on the antler beam so as the shorter distance between the two sides of the beam is perforated) has been made using a suitable tool on the main beam area just distal of the bez tine (removed). The lip or edge of this perforation on both the lateral and medial aspects displays evidence of working or broadening on the somewhat smoothed outer edges which may be indicative of 'drilling' from both sides rather than from one side only, using a suitable tool such as a tapered flint borer or a metal tool, as the perforation is almost circular and appears to have an hour-glass form. There appears to be no misalignment between the two sides although the lateral aspect is slightly larger than the medial aspect (see below). Cutmarks are evident on the medial aspect of the perforation lip on the antler main beam itself. A distal-medial perforation is located within the interior antler bony spongy core itself (interior of the perforated section itself); this is not naturally occurring and may have occurred during the insertion of the haft or through use of the object.

A portion of the interior spongy bone is apparent at the distal end where the antler edges are smoothed or blunted to a degree (worn but non-naturally occurring while the antler was still attached to the pedicle (specialised frontal cranial bone) of the male adult red deer). Wear was observed mainly on the distal aspect i.e. away from cranium/coronet and slight wear also had occurred at the junction of the brow tine and main antler beam, although equally this smoothing may have resulted at the time the brow tine was removed either during the life of the red deer male (while the hard antler was attached to the cranium after the velvet was shed from approximately September through to March/April) or after death by anthropogenic alterations.

Figure 40 Antler hammerhead/macehead (11E0316:0X:252) from Moneen Cave (Elaine Lynch).

The maximum diameter of the coronet/burr is 62.78mm (circumference of the coronet *c*. 87mm). The minimum width of the main beam measured between brow and bez tines respective junctions with the main beam is 43.85mm. The transverse perforation in the main beam is located 35mm from the coronet (or the burr – the proximal or basal portion of the antler). The maximum medial width of the perforation is 24.93mm x 28.4mm whereas the maximum lateral width of the perforation is 25.3mm x 33.8mm. The distal end is artificially rounded or worn on the antler bone itself near the position of the bez tine. The maximum length of the object measured between the distal and proximal areas is 63.9mm and the maximum width of the distal smoothed 'edge' is 35.67mm (medial aspect).

The object is a naturally shed left antler (proximal portion of main beam with the brow and bez tines absent) from an adult male red deer that has been worked. The almost circular perforation located on the main beam is likely to be a shaft-hole to hold, perhaps, a wooden haft or other suitable fitting thereby allowing the antler object to function as some sort of an implement. The distal end of the antler artefact where the antler bone edges are smoothed or blunted to a degree (antler bone is worn but this did not naturally occur during the time when this left antler was attached to the adult male red deer) displays visible spongy bone. It is plausible that this could be a location where a suitable stone or metal cutting edge (flake, axe head etc.) was inserted and the object was used as an 'antler sleeve' or, alternatively, this area was blunted or smoothed (subject to wear) when the object was used for a specific function in a specific way. Not only has such a type of tool, derived from the proximal area of red deer antlers, been previously suggested in woodworking in terms of effectively splitting timber, but such tools also probably 'served as universal tools with a range of functions' (Riedel *et al*. 2004). Therefore the exact nature of the use of such an object may be open to other speculative interpretations by other researchers.

14. Middle/Late Bronze Age pottery

Elaine Lynch and Helen Roche

An assemblage of 353 prehistoric pottery sherds representing at least six Middle/Late Bronze Age vessels was recovered from Moneen Cave. No complete vessel was found. Sherds were recovered from 13 of the 23 contexts recorded during the excavation: C.0X, C.1, C.2, C.3, C.4, C.8, C.10, C.13, C.14, C.15, C.16, C.18 and C.19. The majority of the sherds were found scattered through the cave chamber, and in a number of deposits in the lower levels of the cave where material is likely to have percolated down from the main chamber. It seems that fragmented rather than complete vessels were originally placed in the cave.

The assemblage comprises 11 rim fragments, 138 body sherds, 9 base angle sherds, 7 base sherds and 187 crumbs, that reach a combined total weight of 2314.55g. The assemblage was in good condition; most sherds displayed few surface or edge breaks and were well preserved. Portions of the profiles could be reconstructed and represented large flat-bottomed, bucket- or barrel- shaped forms.

Both the external and internal surfaces of the six vessels were smoothed during the construction phase as evidenced by striation marks on the surfaces. Vessel 1 was also slipped on the internal surface and there were fibrous marks on the internal surface indicative of material having been set within the vessel during the construction phase. Vessel 5 had some similar fibrous marks that may also relate to smoothing of the surfaces. Vessel 6 was the only vessel with evidence of weathering. Approximately 20% of the upper portion of the vessel could be refitted, and there is some suggestion that this pot – or at least a sizable part of the vessel – broke *in situ* following deposition in the cave. In the lower portion of this vessel, a number of sherds were weathered on the external surface exposing a gritty core with tempers protruding. This level of weathering was not apparent on the upper part of the pot. One possibility is that vessel 6 was in a fragmentary state when outside the cave where it was subjected to differential weathering, then weathered and unweathered sherds were gathered up and placed in the cave. Alternatively, and more likely, is that the upper part of the intact pot was somehow protected but the lower section was exposed to weathering, thereby explaining the different condition. This could have happened outside the cave or inside (e.g. if there was consistent dripping water).

Some sherds from vessels 3 and 6 had evidence of fire-blackening on the external surface, which may have occurred during the initial firing process or subsequent firings. The majority of sherds in the Moneen assemblage were covered in a hard, thin white wash of calcite which must have accumulated after the pottery was deposited in the cave. The calcite was on the external and internal surfaces and along breaks in the sherds, indicating that the vessels were broken prior to, or soon after, being deposited in the cave.

Due to the fabric, rim profiles and base sherds, the Moneen Cave assemblage represents material spanning the end of the Middle Bronze Age to the beginning of the Late Bronze Age (Figure 42). Plain bucket- or barrel-shaped domestic vessels emerged in the Middle Bronze Age around 1500 BC and continued to dominate into the Late Bronze Age (*c*. 1100-800 BC) with pottery becoming coarser and thicker but generally better fired (Grogan and Roche 2010: 41-3). These vessels have a limited form with simple rounded rims with an internal bevel, and occasionally broad expanded rims. Decoration is rare. The plain wares of the Late Bronze

Vessel no.	Rims	Body	Base-angle	Base	Temper size	Temper amount	Thickness mm	Weight g
1	4	60	2		large	moderate	7-11	649.4
2	1	2			small	Rich	12.5-14	42.7
3	2				small	moderate	13.5-14.5	30.8
4	2	2			small	moderate	10-12	20
5		38	7	7	fine	moderate	9-14	813.4
6	2	37			small	Rich	8-16	644.3
Total	11	133	8	7				2,076

Figure 41 Detail of the pottery assemblage from Moneen Cave.

Age are most commonly associated with domestic activity (such as the hillforts of Dún Aonghasa, Inis Mór, Co. Galway and Mooghaun, Co. Clare) but have been found associated with funerary contexts in the form of cremations (such as at Kilbane, Co. Limerick and Priestnewtown, Co. Wicklow) (Grogan and Roche 2010: 41-3).

Because plain bucket-shaped forms emerged in the Middle Bronze Age, and because the fabric of the Moneen Cave pottery is much finer than the coarse material from the Late Bronze Age, it is probable that this cave assemblage dates to the transitional period between the Middle and Late Bronze Age (Figure 42).

Similar rim forms with internal bevels can be found at Late Bronze Age sites such as Haughey's Fort, Co. Armagh (Grogan and Roche 2010: illus. 10 vessel G); Lough Gur, Circle L, Co. Limerick (Grogan and Roche 2010: illus. 10 vessel H); and Mooghaun, Co. Clare (Grogan 2005). The Late Bronze Age vessels (vessels 7, 8 and 11) from Ballylegan, Co. Tipperary (Grogan and Roche 2009: fig. 9.9) have similar rim and vessel forms to vessels 2, 3, 4 and 6 from Moneen Cave. Similar parallels can be found at Ballinderry 2, Co. Offaly; Lough Gur, Site C, Co. Limerick; Carrigillihy, Co. Cork (Grogan 2005: fig. 2) and Ballyveelish 2, Co. Tipperary (Grogan 2005: fig. 3). A rim sherd from Curraghtoor, Co. Tipperary (Cleary 2007: 80) is similar

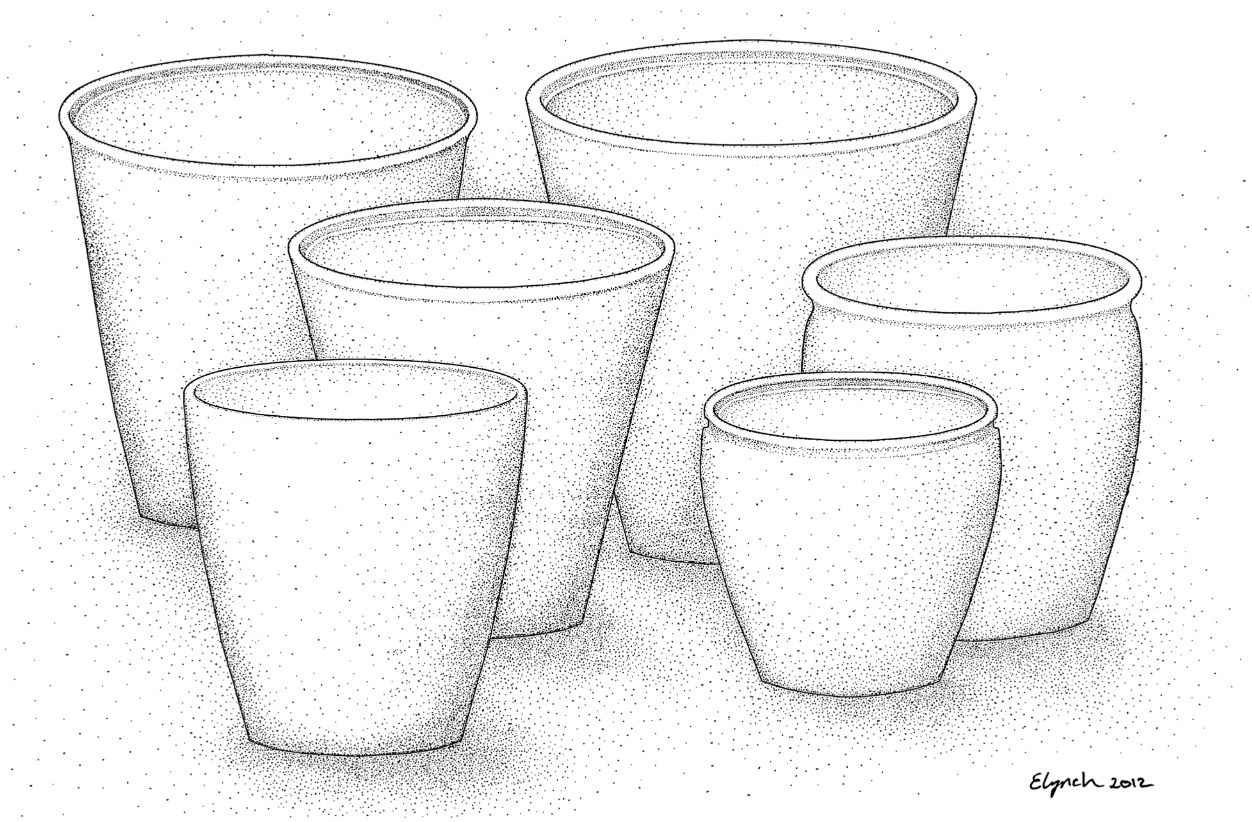

Figure 42 Reconstruction of the six Bronze Age vessel types represented in the pottery assemblage from Moneen Cave (Elaine Lynch).

Figure 43 Vessel 1: exterior of rim sherd (0X:02), body sherds (02:35; 02:43; XX:251; 02:51; 0X:236) and base angle sherd (02:41) (Thorsten Kahlert).

in form to vessel 1 from Moneen Cave and was dated to 1261-1055 BC, placing it within the transition between the Middle and Late Bronze Age. Other parallels for vessel 1 from Moneen Cave include Dún Aonghusa, Co. Galway (Grogan 2005: fig. 2); Moynagh Lough, Co. Meath; and Ballyveelish 2, Co. Tipperary (Grogan 2005: fig. 3).

Pottery catalogue

Vessel 1 (Figures 43-45) Four rim sherds (0X:02, 01:12, 2:37, 2:62), four sherds from close to the rim with internal bevel (2:35, 2:64, 4:192, 18:207), one base angled sherd (2:41), 26 body sherds (0X:01, 0X:226, 0X:227, 0X:228, 0X:231, 0X:236, 0X:238, 0X:241, XX:251, 01:09, 02:42, 02:43, 02:44, 02:45, 02:47, 02:50, 02:51, 02:52 , 02:53, 02:54, 02:55, 02:180, 03:65, 04:183, 04:186, 10:168), and 21 small fragments (02:46, 02:49, 02:73, 02:230, 03:60, 04:185, 04:194, 04:199, 04:201, 04:202, 04:203, 04:206, 10:166, 10:167, 10:169, 10:171, 10:172, 10:174, 10:175, 10:176, 13:184). Weight: 524.9g. In addition, seven pottery sherds have been recovered from various locations within the cave since the excavation. This included 6 body sherds (XX:254, XX:255, XX:256, XX:257, XX:258, XX:259) and 1 base angle sherd (XX:260). Weight: 128.5g. All of these sherds can be associated with vessel 1.

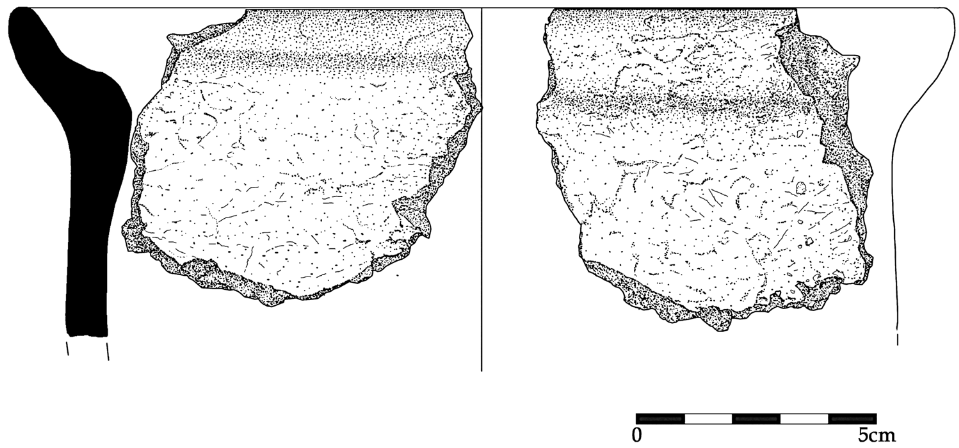

Figure 44 Vessel 1: rim sherd (0X:02); interior view left, exterior view right (Elaine Lynch).

Large barrel-shaped vessel with an outward splayed rim with a high internal bevel. The rim has an estimated diameter of 200mm. The fabric is hard, compact and moderately tempered with dark grey large (>3mm<5mm) angular granitic rock. The surfaces have been smoothed but have a slightly rough texture with tempers protruding the external surface. The internal surface has been slipped and there are fine impression marks on the internal surface indicative of a fibrous substance that may have been placed within the vessel when it was still wet at construction stage. There are areas on the surfaces of the sherds where the slip has peeled off (or may not have been applied properly) and the pre-slipped surface is visible. Calcite from the cave has formed a thin hard white wash on the external and internal surfaces and on the sides of a number of sherds. Thickness: 7-11mm. Colour: Orange exterior with a dark grey core and a mid-brown internal surface.

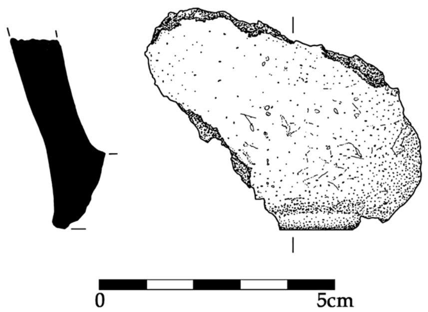

Figure 45 Vessel 1: base angle sherd exterior (02:41) (Elaine Lynch).

Vessel 2 (Figures 46 and 47) One rim sherd (01:29), one sherd from near the rim with internal bevel (19:210), and one body sherd (01:151). Weight: 42.7g. Flat topped rim with a slight internal bevel set 19mm below the rim. The rim has an estimated diameter of 200mm. The fabric is hard, compact and richly tempered with small (>1mm<3mm) angular quartzite rock. The surfaces have been smoothed but are rough in texture. Tempers can be seen on the surfaces but do not protrude. Smoothing striations can be seen on the internal surface of the rim sherd. Calcite has formed a hard, thin white wash on the external and internal surfaces of the rim sherd. Thickness: 12.5-14mm. Colour: Mottled brown exterior with a dark brown core and an orange internal surface.

Vessel 3 (Figures 46 and 48) One rim sherd (0X:240), and one small rim fragment (19:213). Weight: 30.8g. Flat topped rim with an internal bevel set 21mm below the rim. The rim had an estimated diameter of 180mm. The fabric is hard, compact and moderately tempered with small (>1mm<3mm) angular quartzite rock. The surfaces are smooth and tempers can be seen but do not protrude the surfaces. Smoothing striations can be seen on the internal surface of the rim. The rim is fire-blackened on the external surface. Calcite has formed a thin, hard white wash on the internal surface and along the break of the rim sherd. Thickness: 13.5-14.5mm. Colour: Reddish orange exterior with a dark grey core and a yellowish orange internal surface.

Vessel 4 (Figures 46 and 49) One rim sherd (15:187), one small rim fragment (15:198), and two small body sherds (01:157, 01:17). Weight 20g. Rounded out-turned rim. The fabric is hard, compact and moderately tempered with small (>1mm<3mm) angular quartzite rock. The surfaces are smooth and tempers can be seen on the surface but do not protrude. Small pieces of calcite have formed a thin, hard white wash on the external surface. Thickness: 10-12mm. Colour: Mid brown exterior with a dark brown core and an orange internal surface.

Figure 46 Exterior of rim sherds from vessel 2 (19:210), vessel 3 (0X:240) and vessel 4 (15:187) (Thorsten Kahlert).

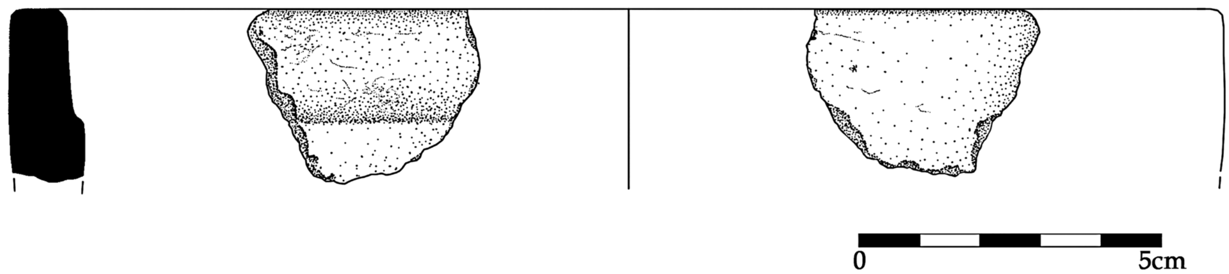

Figure 47 Vessel 2: rim sherd (19:210); interior view left, exterior view right (Elaine Lynch).

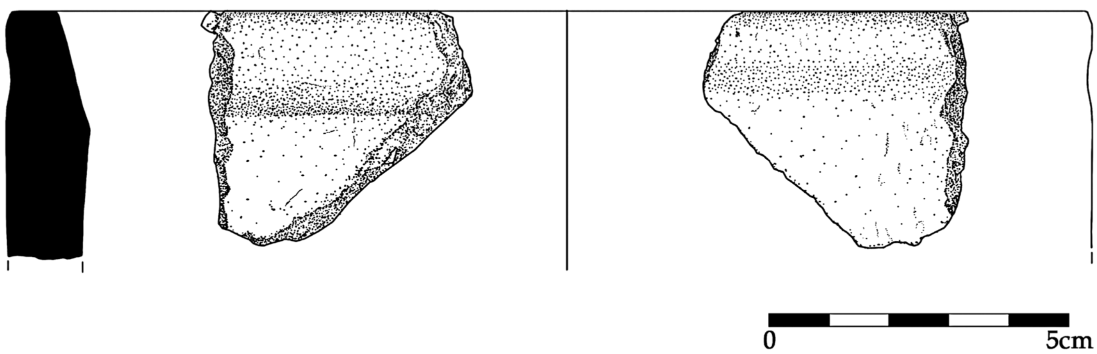

Figure 48 Vessel 3: rim sherd (0X:240); interior view left, exterior view right (Elaine Lynch).

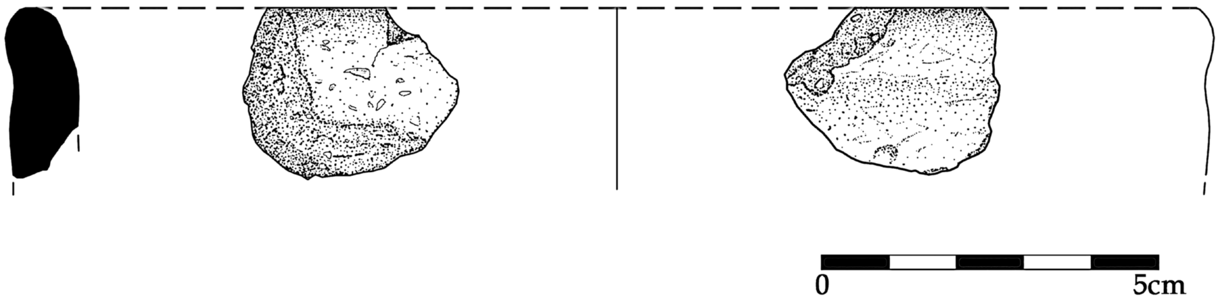

Figure 49 Vessel 4: rim sherd (15:187); interior view left, exterior view right (Elaine Lynch).

Figure 50 Vessel 5: exterior of base angle sherd (0X:249) (Thorsten Kahlert).

Vessel 5 (Figures 50-52) Seven base angle sherds (0X:242, 0X:249, 0X:250, 01:04, 01:25, 01:155, 15:189), seven base sherds (0X:229, 0X:232, 0X:233, 0X:237, 0X:246, 01:20, 02:58), 23 body sherds (0X:224, 0X:225, 0X:234, 0X:235, 0X:239, 0X:243, 0X:244, 0X:245, 0X:248, 01:10, 01:16, 01:23, 01:26, 01:27, 01:36, 01:153, 01:156, 02:56, 03:178, 03:179, 10:170, 15:188, XX:261), and 15 small fragments (08:59, 08:63, 01:15, 01:18, 01:22, 01:32, 01:76, 01:161, 04:193, 04:200, 10:173, 15:77, 15:190, 15:196, 15:197). Weight: 813.4g. Flat-bottomed barrel-shaped vessel with a base diameter of 140mm. The fabric is hard, compact and moderately tempered with fine (<1mm) angular quartzite rock. The surfaces are very smooth but slightly uneven. The base has a slight subtle protruding foot. Smoothing striations from a fibrous substance are visible on the surfaces of the sherds. The base is very flat with a smooth external surface but has a gritty internal surface due to protruding tempers. Calcite from the cave has formed a thin, hard white wash on the external and internal surfaces and on the sides of a number of sherds. Thickness: 9-14mm. Colour: surfaces are orange with a dark grey core. Five base sherds could be refitted (0X:237, 0X:246, 0X:229, 0X:232, 02:58); as well as two base angle sherds (0X:242, 01:04); and two body sherds (0X:248, 0X:225).

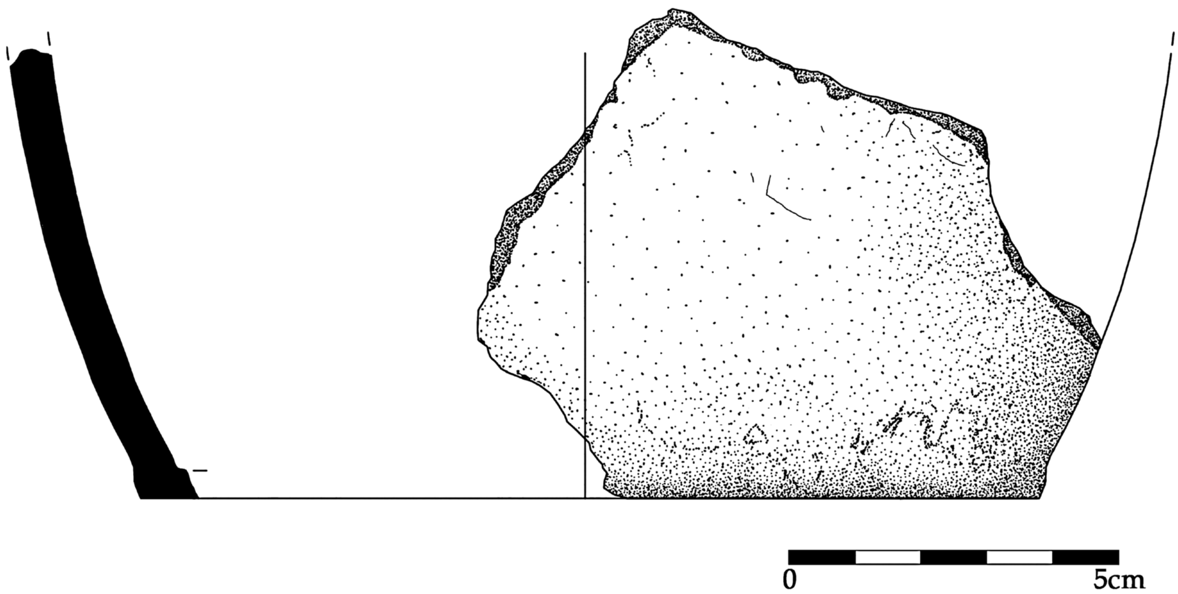

Figure 51 Vessel 5: external surface of base angle sherd (0X:249) (Elaine Lynch).

Figure 52 Vessel 5: interior of base sherds, i.e. inside the pot (0X:232; 0X:233; 02:58; 0X:246; 0X:237; 0X:229) (Thorsten Kahlert).

Figure 53 Vessel 6: exterior of rim sherds (19:211; 19:214) and body sherds (19:215; 19:223; 19:212) (Thorsten Kahlert).

Vessel 6 (Figures 53 and 54) Two rim sherds (19:211, 19:214), 31 body sherds (0X:247, 01:03, 01:05, 01:06, 01:07, 01:11, 01:13, 01:14, 01:21, 01:24, 01:30, 01:40, 01:154, 01:158, 02:39, 02:57, 08:165, 19:66, 19:67, 19:68, 19:69, 19:74, 19:78, 19:212, 19:215, 19:216, 19:218, 19:219, 19:221, 19:222, 19:223) and six small fragments (01:28, 01:31, 01:33, 01:152, 01:159, 19:217). Weight: 644.3g. Large barrel-shaped vessel with a rounded rim with an internal bevel set 17mm below the rim and a slight external constriction forming a short neck. The rim had an estimated diameter of 200mm. The fabric is hard, compact and richly tempered with small (>1mm<3mm) pieces of crushed angular quartzite rock. The surfaces of the upper portion of the vessel are well smoothed. However, a number of sherds lower down the vessel are weathered on the external surface, exposing the temper and creating a gritty texture. Some of the sherds are fire blackened on the external surface. Smoothing striations can be seen on the external surface of the sherds. There are very fine impressions on the external surfaces of the sherds (especially visible on rim sherd 19:214) which may have been created by a fibrous substance during the construction phase. Calcite from the cave has formed a thin, hard white wash on the external and internal surfaces and on the sides of a number of the sherds. Thickness 8-16mm (the vessel is thickest near the rim and thins out lower down). Colour: Orange exterior with a mid-grey brown core and an orange internal surface. Two rim and four body sherds could be refitted (19:211, 19:214, 19:215, 19:212, 19:69, 19:223). Two other body sherds refitted together (19:66, 19:222); and two others conjoined (19:216, 19:218).

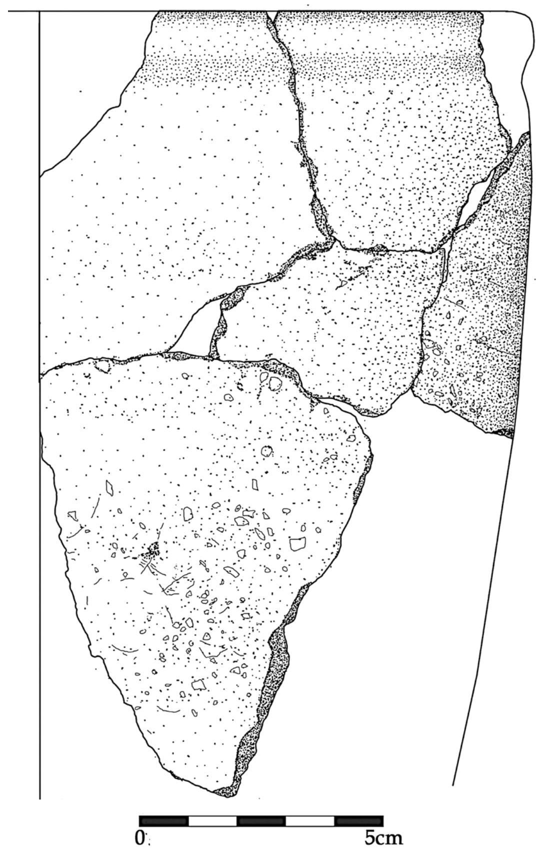

Figure 54 Vessel 6: exterior of refitting sherds (19:211; 19:214; 19:69; 02:39; 19:233) (Elaine Lynch).

Crumbs Additional pottery recovered consisted of *circa* 187 crumbs (01:08, 01:19, 01:34, 01:75, 01:160, 02:38, 02:48, 02:61, 02:162, 04:204, 13:181, 14:182, 15:191, 15:195, 16:205, 18:209, 19:220). Due to the size of the crumbs, it is not possible to assign them to a particular vessel but the fabric is similar to vessels 2-6. Weight: 109.95g.

15. Post-medieval human skeletal remains

Catriona McKenzie

This section provides the results of osteological and palaeopathological analyses of the post-medieval skeleton from Moneen Cave. The remains were those of an adolescent aged 14-16 years at the time of death. A tooth sample was submitted for DNA analysis to Mike Taylor (Section 16) and the results indicated that this was a male individual. The left first metatarsal returned a date of 265±24 BP (UBA-19933) and the right mandibular second pre-molar returned a date of 407±26 BP (UBA-19275) (Figure 27). Stable isotope analysis was undertaken on the metatarsal; the $\delta^{13}C$ value was -21.0 and the $\delta^{15}N$ value was 7.9, indicating a diet based on C_3 plants with very little animal protein.

Location of remains in cave and position of body

The human skeletal remains were recovered from two separate areas of the cave. The majority of the post-cranial skeleton was discovered in the niche (0.6m x 0.6m) in the north wall of the cave. However, all the skull bones – with the exception of the mandible – were found in the main chamber approximately 2.75m from the niche (Figure 11). These included fragments of the frontal bone, right and left maxilla, right and left parietal, right and left temporal, right and left nasal bones, right and left zygomatic, occipital, sphenoid and one internal nasal conchae. The mandible, the right maxillary first incisor, the right maxillary canine and the right maxillary second pre-molar were all found in the niche, but the right maxilla was found in the main cave chamber. Conversely, the left mandibular first incisor was found in the cave chamber but fitted the mandible that was found in the niche. Similarly, the occipital condyles found in the chamber articulated with the first cervical vertebra from the niche. While it is technically possible that the skeletal remains from these two areas could belong to two different individuals, it is highly unlikely that this is the case here. The lack of duplication of skeletal elements and the clear articulations between bones indicates that this is almost certainly a single individual.

Although the skeleton was almost complete, it was not possible to discern the original position of the individual as the bones had been disturbed prior to excavation. It is considered likely that the individual was originally placed, or died, in the niche. Cranial bones do not completely fuse together until adulthood and, as such, it is reasonable to assume that the skull was moved from the niche into the chamber during decomposition while the soft tissues held the cranial bones together. The presence of a large rock in the middle of the cave precluded the head from rolling into the chamber by natural means (Figure 11). Furthermore, the cave entrance is very small and sheltered and there is no evidence that the cave flooded during periods of heavy rainfall. It is therefore highly unlikely that the bones were moved by water action; although this scenario cannot be entirely dismissed. The disturbance to the skeleton was probably caused by a carnivorous animal or rodent activity. In forensic cases in Britain and Ireland, the badger (*Meles meles*), fox (*Vulpes vulpes*) and dog (*Canis familiaris*) are all well-known scavengers of human remains (Ruffell and Murphy 2011: 152), and any one of these animals could have entered the cave and disturbed the skeleton. Given the post-medieval date of the Moneen skeleton, a wolf (*Canis lupus*) should also be considered a possible scavenger that could have interfered with the skeletal remains. Although the position of the skull was most likely caused by animal activity, no carnivore puncture marks or rodent gnawing marks were evident on any of the skeletal elements examined.

The position of the skeleton is best illustrated in the following five images, starting with Figure 55 – the uppermost level and majority of the skeleton. When these bones were removed, the bones in Figure 56 were exposed, and so on with Figures 57 and 58, ending with Figure 59 – the lowest level. See also Appendix 4.

Figure 55 illustrates the position of the skeletal elements prior to excavation. Although there were

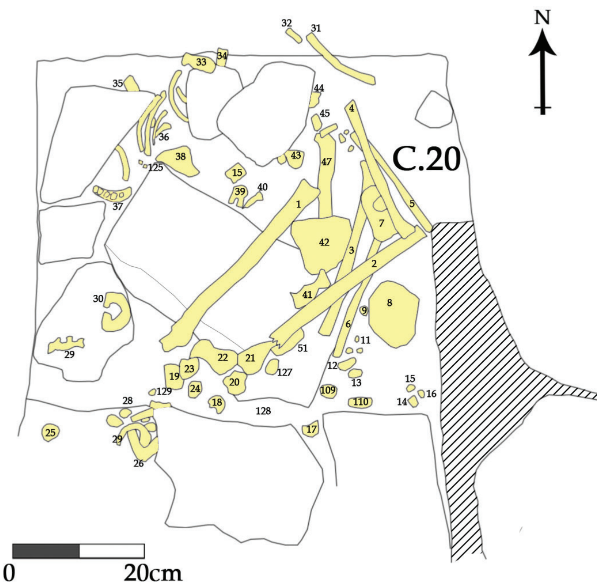

Figure 55 Position of human bones in niche from pre-excavation down to lowest level.

no clear anatomical connections, it is likely that this skeleton represents a primary deposit. Some of the very small hand and foot bones (such as distal hand and foot phalanges) were recovered from the niche; these bones would probably have been absent if this skeleton was a secondary deposit. The skeletal position was obviously disturbed, likely by animal activity, during and/or following the decomposition of the soft tissues. For example, the proximal end of the left femoral diaphysis (Bone 1) is lying in the southwest of the niche; the left femoral head epiphysis (Bone 25) is no longer adjacent to the diaphysis; and the left ilium (Bone 8) is approximately 0.4m from the left pubis (Bone 26). The left foot (Bones 12-17) which includes the calcaneus and cuboid, were not in correct anatomical position. The right scapula (Bone 33) is approximately 20cm from the right humeral diaphysis (Bone 4). Likewise, the right radial diaphysis (Bone 5) is separated from the right ulnar diaphysis (Bone 31). It is likely that the right leg was tightly flexed. The right femoral diaphysis (Bone 2) is overlying the right tibial diaphysis (Bone 3) and the right fibular diaphysis (Bone 6). The right distal tibial epiphysis (Bone 21), the right calcaneus (Bone 19), and the right talus (Bone 20) were all clustered together with the right proximal femoral diaphysis (Bone 22) and the right femoral head epiphysis (Bone 18).

Figure 56 shows the left tibial diaphysis, with the left proximal tibial epiphysis and the left tibial tuberosity (Bone 71) and the left fibular diaphysis (Bone 72). The

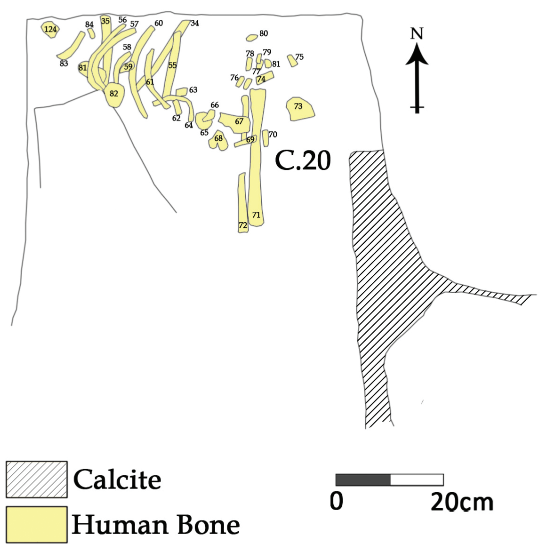

Figure 56 Position of human bones in niche from pre-excavation down to lowest level.

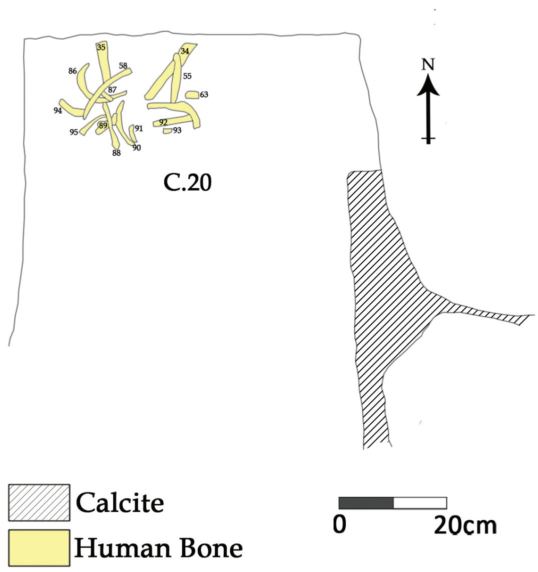

Figure 57 Position of human bones in niche from pre-excavation down to lowest level.

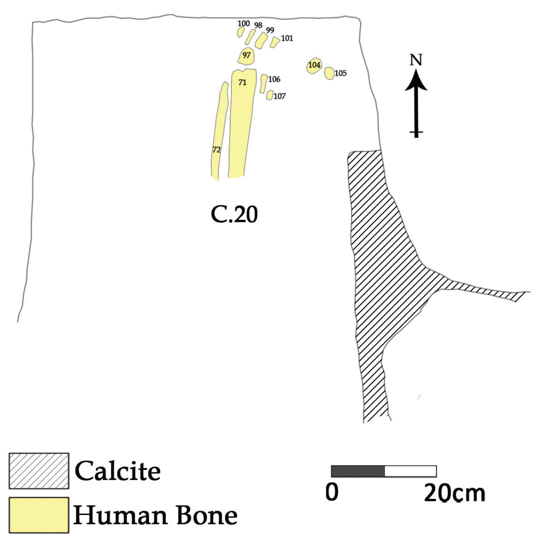

Figure 58 Position of human bones in niche from pre-excavation down to lowest level.

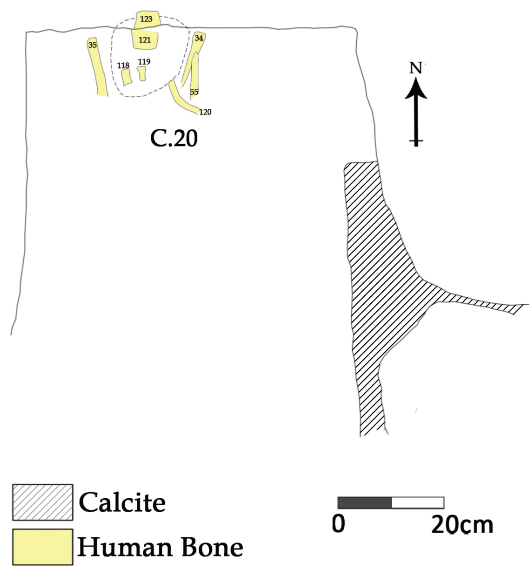

Figure 59 Position of human bones in niche from pre-excavation down to lowest level.

cluster of bones to the north of the lower leg bones include the right third (Bone 74), fourth (Bone 78) and fifth (Bone 75) metacarpals; the right scaphoid (Bone 80); left third metacarpal (Bone 79); a proximal hand phalanx (Bone 77); the right mandibular ramus and an additional proximal hand phalanx (Bone 81).

Figure 57 shows the left humeral diaphysis (Bone 35), left radial diaphysis (Bone 34) and left ulnar diaphysis (Bone 55). These arm bones are accompanied by two proximal hand phalanges (Bone 63 and Bone 93); a fragment of the lateral diaphysis of the right clavicle (Bone 87); the fourth cervical vertebra (Bone 89); a left rib (Bone 86); a right rib (Bone 90) and two unsided rib fragments (Bone 92 and Bone 94).

Figure 58 shows the proximal left tibia (with the proximal epiphysis and the tibial tuberosity) (Bone 71), the left fibular diaphysis (Bone 72) and the left patella (Bone 97). The following hand bones are also identified: the right first metacarpal (Bone 98); a proximal hand phalanx (Bone 106); an intermediate hand phalanx (Bone 99); the right trapezium (Bone 100); and the left capitate (Bone 107). Bone 101 is a collection that included the right distal radial epiphysis, the right hamate, a proximal hand phalanx and a distal hand phalanx. The right patella (Bone 104) is also present.

Finally, Figure 59 shows the left humeral diaphysis (Bone 35), left radial diaphysis (Bone 34) and left ulnar diaphysis (Bone 55). Bone 120 and 121 are a cluster of the first cervical vertebra, third cervical vertebra, first thoracic vertebra, second thoracic vertebra and a right rib. Two further cervical vertebra are depicted, the fifth cervical vertebra (Bone 119) and the sixth cervical vertebra (Bone 118). Bone 123 includes the medial diaphysis of the right clavicle; the left and right first rib; the left second rib; the seventh cervical vertebra; one unnumbered thoracic vertebra; three rib fragments; one intermediate hand phalanx; and the right maxillary first incisor.

Results of analysis

Methodology

The approximate completeness and degree of fragmentation affecting the skeleton were both graded using percentages: <25%, 25-50%, 50-75% and >75%. Abrasion and erosion of the bone surface were recorded according to the grading system detailed by McKinley (2004: 16). The skeleton was allocated an overall surface preservation grade which ranged from Grade 0-5. Grade 0 indicated no modifications to the bone surface, while Grade 5 indicated extensive erosion of the bone cortex. Any discolouration on the bones was recorded with details of the bone, the aspect of the bone, and the percentage of the bone affected (McKinley 2004: 15).

The age-at-death was estimated using four techniques: epiphyseal fusion rates (Schaefer *et al*. 2009; Scheuer and Black 2000; Schwartz 2007); diaphyseal lengths of long bones (Scheuer and Black 2000); dental eruption (Ubelaker 1989: 64); and dental calcification (Moorrees *et al*. 1963 modified by Smith 1991). Generally, dental calcification is thought to be the most reliable non-adult ageing technique (Brickley 2004: 21) and therefore emphasis was placed upon these results. Palaeopathological lesions were described using standardised unambiguous palaeopathological and clinical descriptive terminology. Specific recording systems were used to classify the palaeopathological lesions where possible. The presence or absence of calculus, dental caries, enamel hypoplasia and dental attrition were recorded for each tooth, and periodontal disease and dental abscesses were recorded for each tooth socket.

Condition

The human bone assemblage from Moneen Cave represents the remains of one individual. This skeleton had greater than 75% of the expected skeletal elements present for analysis (Figure 60). The following skeletal elements were absent: the ethmoid; one internal nasal conchae; the vomer; the right and left palatine; the right and left lacrimal bones; three thoracic vertebrae; the first and second lumbar vertebrae; the fifth sacral vertebra; the coccyx; the sternum; two left ribs; five right ribs; the left trapezium; the right and left triquetral; the right and left pisiform; the right trapezoid; the left first metacarpal; four distal hand phalanges; the right fourth metatarsal; two proximal foot phalanges; and six distal foot phalanges. The vast majority of these bones would have been very small in size. In addition to being relatively complete, the bones available for analysis were mainly intact as fewer than 25% of the skeletal elements were recorded as fragmented. The cranial bones, vertebrae, ribs, and foot bones were the skeletal elements most commonly affected by fragmentation. Overall, the surface bone preservation was recorded as a Grade 2 according to McKinley's (2004: 16) system. This indicates that the bone preservation was generally good, but on most skeletal elements there was patchy surface erosion which penetrated the cortex of the bone. In addition, a number of bones displayed calcite staining (Figures 61 and 62). Slight surface flaking was evident on the left tibial diaphysis affecting between one third and two thirds of the posterior surface of the bone. No animal or rodent marks were identified.

Age and height

The diaphyseal lengths of the long bones were measured to provide an estimation of age at time of death (Figure 64).

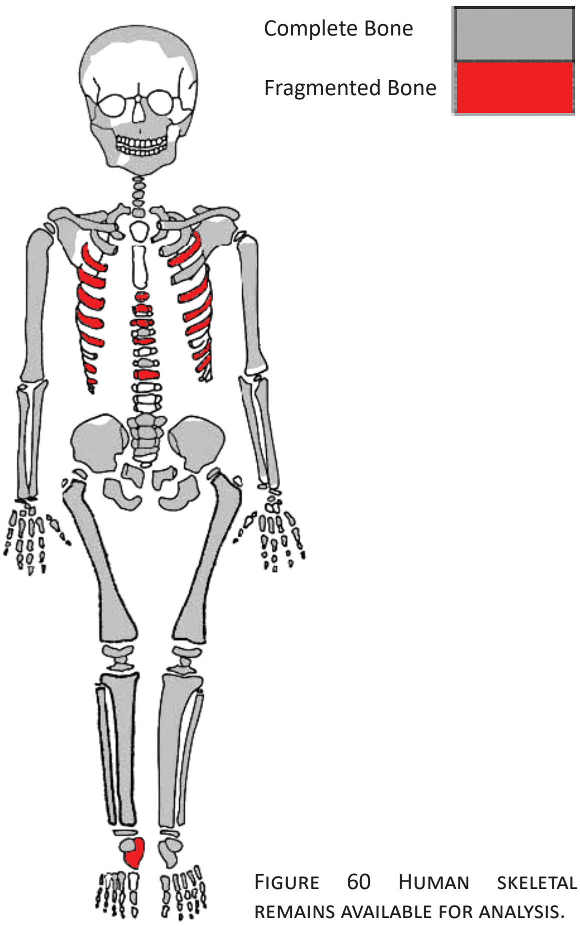

Figure 60 Human skeletal remains available for analysis.

When compared to modern data, the results range from 7.5 to 8.5 years of age. Fusion at the primary ossification centres and epiphyseal fusion were also assessed to provide an indication of the age of this individual. The results are outlined in Figure 65 and Figure 66 respectively.

Post-cranial assessment of the primary centres of ossification in the skeleton suggests that this individual was at least 5-8 years of age at time of death as the ischiopubic ramus was fused. The right tibial tuberosity was fused to the right proximal tibial epiphysis which indicates that this individual was likely to be at least 14 years of age at time of death (Schaefer *et al*. 2009: 280). The left tibial tuberosity was also fused to the left proximal epiphysis but had been broken post-mortem.

The degree of dental calcification was assessed following the criteria developed by Moorrees *et al*. (1963) and modified by Smith (1991). The right maxillary third molar was situated in the alveolar bone and so could not be assessed. The left maxillary third molar had between a quarter and a half of the root developed which indicates that this individual was between 14.5-15.1 years of age at time of death. The right mandibular third molar was located in the alveolar bone and could not be assessed. The left mandibular third molar had approximately one quarter of the root developed which indicates that this individual was approximately 14.8 years at time of

Figure 61 Right distal ulna with calcite deposit (Thorsten Kahlert).

Figure 62 Right tibia with calcite deposit (Thorsten Kahlert).

Skeletal element	Description of calcite staining
Right mandible	Calcite staining and accretions on right mandibular ramus and condyle; less than one third of bone surface affected.
Left clavicle	Slight calcite staining on left lateral clavicle on inferior aspect of the bone; less than one third of bone surface affected.
Left humerus	Calcite staining on left proximal humeral diaphysis on anterior aspect of the bone; less than one third of bone surface affected.
Right humerus	Calcite staining affecting right distal humeral diaphysis; less than one third of bone surface affected.
Right ulna Figure 61	Calcite staining on distal right ulna; between one third and two thirds of the bone surface affected.
Right femur	Calcite staining on right proximal femoral diaphysis; less than one third of anterior and posterior bone surface affected.
Right tibia Figure 62	Localised calcite staining on right proximal to mid diaphysis of tibia; less than one third of bone surface affected.

Figure 63 Calcite staining on specific skeletal elements.

Bone	Length (mm)	Age (yrs)
Right humerus	221	8-8.5
Left humerus	N/R	---
Right radius	170	8-8.5
Left radius	N/R	---
Right femur	N/R	---
Left femur	311	7.5-8
Right tibia	259	7.5-8
Left tibia	259	7.5-8
Right fibula	254	8-8.5
Left fibula	N/R	---

Figure 64 Age estimation using diaphyseal lengths of long bones; the age is estimated using modern data after Scheuer and Black (2000) (N/R = not recordable).

Skeletal element	Fusion	Approx. age when fusion is complete
Partes laterales to squama	Fused	1-3 yrs
Pars basilaris to partes laterals	Fused	5-7 yrs
Spheno-occipital synchondrosis	Unfused	13-18 yrs (m)
Cervical vertebrae NA to NA	Fused	2 yrs
Cervical vertebrae NA to centra	Fused	3-4 yrs
Thoracic vertebrae NA to NA	Fused	2 yrs
Thoracic vertebrae NA to centra	Fused	3-4 yrs
Lumbar vertebrae NA to NA	Fused	5-6 yrs
Lumbar vertebrae NA to centra	Fused	3-4 yrs
Ischiopubic ramus	Fused	5-8 yrs
Sacral segments 1-2	Unfused	20-25 yrs
Acetabulum	Unfused	14-17 yrs (m)

Figure 65 Details of the extent of fusion in centres of primary ossification in the post-cranial skeleton after Scheuer and Black (2000) (NA= neural arch).

Skeletal element	Fusion	Approx. age when fusion is complete
Acromial end of clavicle	Unfused	c. 20 yrs
Sternal end of clavicle	Unfused	25-30 yrs
Humeral head	Unfused	25 yrs
Distal epiphyses of humerus	Unfused	18 yrs
Medial epicondyle of humerus	Unfused	19-20 yrs
Proximal epiphysis of radius	Unfused	15-18 yrs
Distal epiphysis of radius	Unfused	20-23 yrs
Olecranon	Unfused	≤23 yrs
Distal epiphysis of ulna	Unfused	≤25 yrs
Proximal epiphyses of metacarpals	Unfused	18-20 yrs
Distal epiphyses of metacarpals	Unfused	18-20 yrs
Ischial tuberosity	Unfused	23-25 yrs
Iliac crest	Unfused	23-25 yrs
Femoral head	Unfused	18-20 yrs
Greater trochanter	Unfused	18-20 yrs
Lesser trochanter	Unfused	18-20 yrs
Distal epiphysis of femur	Unfused	18-23 yrs
Proximal epiphysis of tibia	Unfused	20-23 yrs
Distal epiphysis of tibia	Unfused	18-20 yrs
Proximal epiphysis fibula	Unfused	23-25 yrs
Distal epiphysis of fibula	Unfused	20 yrs
Calcaneal epiphysis	Unfused	20-22 yrs
Proximal epiphyses of metatarsals	Unfused	18-22 yrs
Distal epiphyses of metatarsals	Unfused	18-22 yrs

Figure 66 Details of epiphyseal fusion in the post-cranial bones after Schwartz (2007, 232-3).

death. In addition, all of the permanent teeth were fully erupted with the exception of the third molars which had been in the process of erupting. This suggests that the individual was approximately 15 years of age at time of death (Ubelaker 1989: fig. 71).

Overall, assessment of the epiphyseal fusion rates, dental calcification and dental eruption indicate that this individual was between 14 and 16 years of age at the time of death. The assessment of the diaphyseal lengths of the long bones provided a younger age estimate, but this is likely to be because of comparison to modern data: typically children grow faster in modern populations than they did in the past.

The diaphyseal length of the femur is thought to represent approximately 91% of the total length of a non-adult femur. An estimation of living stature was calculated using the femoral length/stature ratio developed by Feldesman (1992). The equations derived for male individuals were applied and resulted in an estimated living stature of 124.6cm (4ft. 1in.) for this adolescent.

Growth is affected by a number of factors including diet, general health, and genetic and hormonal influences. In infants, delayed growth is strongly related to maternal health and nutrition during pregnancy. Infants who are born premature often have a low birth weight which may cause stunted growth in later life. When delayed growth occurs in older children it is predominantly caused by malnutrition, prolonged periods of poor health, or infection (Larsen 1997: 13). Children affected by delayed growth will be noticeably smaller when compared to children who have adequate nutrition and are in good health. It is important to note that the growth data derived from archaeological populations represents the children who failed to survive the growth period, i.e. those that were the least healthy in society and so did not survive into adulthood (Mays 2007: 97).

The skeletal assemblage from medieval Ballyhanna, Co. Donegal is the only large skeletal assemblage in Ireland on which research has been undertaken on growth patterns (McKenzie and Murphy forthcoming). When the diaphyseal lengths of the long bones from the Moneen skeleton are compared with the average diaphyseal lengths of the long bones from the Ballyhanna assemblage, it is clear that the Moneen individual had shorter diaphyseal bone lengths than individuals of comparable age. The diaphyseal long bone lengths in the Moneen skeleton were comparable to children who were aged between 11 and 14 years of age at Ballyhanna (Figure 67). When the data from the Moneen skeleton is compared to data from Wharram Percy – a late medieval skeletal collection from Yorkshire – it is clear that the difference is less marked; in this case the Moneen bone lengths are comparable with individuals who were between 10.5 and 15.5 years of age at the time of death.

Bone	Length (mm)	Approx. age (yrs) Ballyhanna	Approx. age (yrs) Wharram Percy
Right humerus	221	11-13	10.5-11.49
Right radius	170	12-14	12.5-15.5
Left femur	311	11-13	12.5-15.5
Right tibia	259	12-14	12.5-15.5
Left tibia	259	12-14	12.5-15.5
Right fibula	254	12-14	12.5-15.5

Figure 67 Age estimation using diaphyseal lengths of long bones – Ballyhanna data from McKenzie and Murphy (forthcoming) and Wharram Percy data from Mays (2007: 96).

The estimated living stature of the Moneen skeleton is comparable to an average 11-12 year old from Ballyhanna (McKenzie and Murphy forthcoming) and an average 12-13 year old from Wharram Percy (Mays 2007: 99). This indicates that the Moneen individual was shorter in stature that the average heights of those of similar age from both Ballyhanna and Wharram Percy. It is probable that the Moneen skeleton was affected by delayed growth, which may have been due to either malnutrition or poor health in infancy or younger childhood. Indeed, there were non-specific indicators of physiological stress in the skeleton which support this theory, such as cribra orbitalia, porotic hyperostosis and Harris lines.

Non-metric traits

Two of the cervical vertebrae – the fifth and the sixth cervical vertebrae – displayed a non-metric trait known as transverse foramen bipartite on the right side of the vertebrae (Figure 68). The corresponding left transverse foramina in both vertebrae had been damaged post-mortem; thus it was not possible to identify whether these anomalies were unilateral or bilateral. This defect is a non-metric trait that is thought to be asymptomatic, which means the individual is unlikely to have been aware of the defect as there would have been no symptoms caused during life. The right transverse foramen in the seventh cervical vertebra was particularly small in size measuring 1.9mm antero-posteriorly by 2.6mm medio-laterally (Figure 69). This is also likely to have been an asymptomatic defect.

Dental health and disease

Details of the dental inventory are shown in Figure 70 with the tooth numbers highlighted in bold as recommended by the *Fédération Dentaire Internationale* (1971) and outlined by Hillson (1996: 8). Teeth 11-18 are the right maxillary teeth, numbered from the first incisor (Tooth 11) to the third molar (Tooth 18); the left maxillary teeth are numbered 21-28, from the first incisor (Tooth 21) to the third molar (Tooth 28); the right mandibular teeth are numbered from 41-48, from the first incisor (Tooth 41) to the third molar (Tooth 48); and finally the left mandibular teeth are numbered 31-38, from the from the first incisor (Tooth 31) to the third molar (Tooth 38).

In total, 21 teeth were present in the tooth sockets, six teeth had been lost post-mortem, four teeth (all of the third molars) were in the process of erupting, and one tooth was present but the associated tooth socket was absent. New bone formation and porosity was evident on the maxilla adjacent to the third molars; it is likely

Figure 68 Transverse foramen bipartite in the fifth cervical vertebra (Thorsten Kahlert).

Figure 69 Small transverse foramen in the seventh cervical vertebra (Thorsten Kahlert).

that these lesions were caused by the eruption of the third molars in the maxilla. On the left side there is porosity and new bone formation on the buccal aspect of the alveolar bone adjacent to the second and third molars. The grey plaque of new bone formation in this area covers an area of approximately 8.44mm supero-inferiorly by 12.7mm medio-laterally (Figure 71). On the right maxilla the porosity and new bone formation is evident on the alveolar bone adjacent to the third molar. Only part of the lesion is evident for analysis, but this measures a minimum of 5.6mm supero-inferiorly by 11.1mm medio-laterally.

The teeth and tooth sockets were examined for evidence of dental disease. The only disease identified was dental calculus. Calculus is a mineralised or calcified plaque deposit that attaches to the crown or root of a tooth (Figure 72) (Hillson 1996: 254). In archaeological populations calculus is often associated with diets that are high in carbohydrates. However, other factors such as poor standards of oral hygiene also contribute to the development of dental calculus. In the Moneen skeleton the severity of dental calculus was recorded according to the grading system devised by Brothwell (1981: 155). Dental calculus was noted on 95.4% (21/22) of the permanent teeth which were present for analysis. The only erupted tooth present that did not display dental calculus was the left maxillary second molar (Tooth 27). The deposits varied from tiny flecks of calculus to moderate deposits on four teeth – the right and left maxillary first molars (Tooth 16 and 26 respectively), the left mandibular second incisor (Tooth 32) and the left mandibular canine (Tooth 33).

Palaeopathology

The second cervical vertebra displayed incomplete fusion of the left costal element of the transverse process which resulted in a cleft in the transverse foramen at this location (Figure 73). This defect is likely to have been asymptomatic and was caused by a developmental delay in the paraxial mesoderm developmental field during the early embryonic stage of development. Defects in this developmental field are commonly caused by genetic factors (Barnes 1994: 58-9). It is not possible to identify whether this was an inherited defect or whether it was caused by environmental factors such as maternal malnutrition during early pregnancy.

The term cribra orbitalia refers to porosity that is found in the orbital roofs. Cribra orbitalia was recorded on a grading scale of Grade 1 to Grade 5 after the methodology outlined by Stuart-Macadam (1991: 109). Grade 1 represents capillary like impressions in the bone and Grade 5 represents large foramina with inter-trabecular connection. The Moneen skeleton had evidence of Grade 5 lesions in both the left and right orbital roof. These lesions were active at the time of death. Until relatively recently, cribra orbitalia was thought to be caused by iron deficiency anaemia in childhood. However, a recent study by Walker *et al.* (2009) has suggested that the link between cribra orbitalia and iron deficiency anaemia is weak. They suggested that porosity in the orbital roofs may be caused by a multitude of conditions, including chronic

	3	1	1	1	1	1	2	1	2	2	1	1	2	1	1	3
Maxilla	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Mandible	**48**	**47**	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
	3	1	2	4	1	1	2	1	1	1	1	1	1	1	1	3

Key: 1 = tooth is present in socket; 2 = tooth lost post mortem; 3 = tooth erupting; 4 = tooth present, but tooth socket absent.

Figure 70 Dental inventory.

infections and deficiencies of Vitamins B_{12}, C and/or D (Walker *et al*. 2009). Factors such as a poor diet, poor hygiene practices, and infectious diseases may all contribute towards the vitamin deficiencies thought to cause cribra orbitalia.

Porotic hyperostosis is the term which applies to porosity on the ectocranial surface of the skull. The Moneen Cave skeleton displayed scattered fine foramina adjacent to the sagittal sutures in the parietal bones, near the parietal bosses (Figure 74), and in the squamous portion of the occipital bone. The lesions appear to be healed at the time of death. Porotic hyperostosis was also traditionally considered to be indicative of iron-deficiency anaemia. However, Walker and colleagues have recently re-examined the evidence for this and suggest that the lesions referred to as porotic hyperostosis are far more likely to be caused by megaloblastic anaemia (Walker *et al*. 2009). In contemporary populations megaloblastic anaemia is common in individuals with depleted levels of Vitamin B_{12} (cobalamin) and Vitamin B_9 (folic acid) (Walker *et al*. 2009: 115). Vitamin B_{12} is mostly found in meat products and, as such, depleted levels of Vitamin B_{12} are found in individuals whose diet is largely vegetarian. Vitamin B_{12} is stored in the liver and in adults the deficiency develops very slowly, however in children the deficiency may become apparent within months of their birth and particularly if fed by mothers who have a depleted supply of Vitamin B_{12} (Walker *et al*. 2009: 114). This may suggest that at some stage during early childhood the Moneen individual had depleted supplies of Vitamin B_{12}. This could have been caused by insufficient meat products in the diet, or it may have been due to insufficient meat products in the mother's diet during breastfeeding. A gastrointestinal infection could also have caused depleted levels of Vitamin B_{12} in this individual.

The term maxillary sinusitis is used to describe an inflammation of the bone in the maxillary sinuses. The lesions in the bone are evident as spicules of new bone formation and pitting or porosity in the maxillary sinuses (Roberts and Manchester 2005: 174). Maxillary sinusitis may be caused by infections or by dental diseases if the floor of the sinus is perforated by an oro-antral fistula (as this causes a connection between the mouth and the sinus) (Roberts and Manchester 2005: 175). Slight maxillary sinusitis was noted in both the left and right maxillary sinus of the Moneen skeleton. In the left sinus, there was spicule formation evident (Figure 75), while in the right sinus pitting was evident on the floor of the maxillary sinus (Figure 76). It is likely that these changes were cause by a respiratory infection.

Harris lines are horizontal lines of increased density that are apparent in radiographs of long bones (Roberts and Manchester 2005: 240). The lines represent periods of arrested bone growth. Harris lines are known as non-specific indicators of physiological stress as they may be caused by both acute and chronic diseases, dietary or psychological stresses (Mays 1995: 511). Several bones of the skeleton had Harris lines (Section 19) but it is not possible to identify the cause of the arrested bone growth in this individual.

Summary

The human skeletal remains from Moneen Cave represent one individual aged between 14-16 years at the time of death. The skeleton was probably initially placed/or died in the niche in the cave and it seems likely that the cranial bones were subsequently moved into the cave chamber at a later date probably during decomposition of the soft tissues. Two cervical vertebrae – the fifth and sixth – displayed a non-metric trait known as transverse foramen bipartite. In addition, a particularly small transverse foramen was noted on the seventh cervical vertebra, but these features are indicative of normal variation in the skeleton as opposed to pathology. The teeth were well preserved and the only dental disease identified was dental calculus which may be indicative of poor oral hygiene or a diet high in carbohydrates. The third molars were erupting at the time of death and there was increased porosity and new bone formation evident on the alveolar bone adjacent to both of the maxillary third molars. There was incomplete fusion of the left costal element of the transverse process in the second thoracic vertebra, but this defect was likely to have been asymptomatic during life.

Active lesions of cribra orbitalia were evident in the orbirtal roofs. These lesions may have been caused by chronic infections and deficiencies of Vitamins B_{12}, C and/or D. Healed porotic hyperostosis was evident on the cranial vault and this may be considered indicative of depleted levels of Vitamin B_{12}. Perhaps the cribra orbitalia and porotic hyperostoses lesions were due to a poor diet or prolonged period of infection during childhood. Lesions indicative of maxillary sinusitis were also identified and these may have been caused by a respiratory infection. Finally, Harris lines in the femora and tibiae provided further evidence of periods of physiological stress in this young individual's life. There was no sign of the cause of death, but the skeletal remains suggest that this young male had survived periods of malnutrition and/or chronic infections during his short life; perhaps one or more of these factors was ultimately the cause of his death.

Figure 71 Porosity and new bone formation on the left buccal maxilla adjacent to the second and third tooth socket (Thorsten Kahlert).

Figure 72 Dental calculus on the first right maxillary molar (Thorsten Kahlert).

Figure 73 Incomplete fusion of the left costal element of the transverse process in the second cervical vertebra (Thorsten Kahlert).

Figure 74 Scattered fine foramina adjacent to the sagittal suture on the right parietal (Thorsten Kahlert).

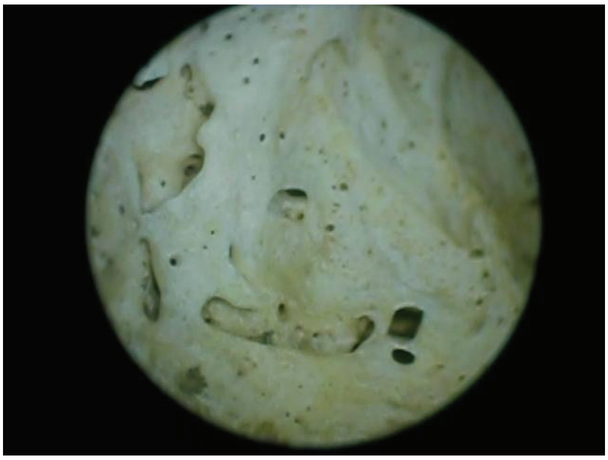

Figure 75 Left maxillary sinus (Deirdre Drain).

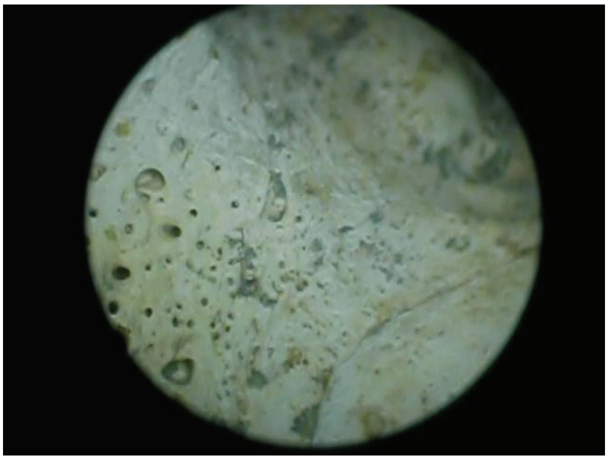

Figure 76 Right maxillary sinus (Deirdre Drain).

16. DNA analysis of the human skeletal remains

Mike Taylor

Two human teeth, both from C.20 in the niche, were subjected to DNA analysis: the 1st right mandibular pre-molar and the left mandibular canine (Figure 77). Samples of tooth powder were extracted by Sheila Tierney at IT Sligo and sent for analysis.

DNA extraction

A modification of the original Boom method (Boom *et al*. 1990), which employs extraction in a chaotropic buffer of high ionic strength, combined with recovery of DNA with pre-washed and size fractionated silica (Sigma-Aldrich S5631), was used to prepare DNA extracts. Samples (80mg and 100mg) of the tooth powder provided were combined with 0.9ml of 6M GUSCN lysis solution, buffered with Tris-Hcl pH 8.0 (Sigma-Aldrich T-93283) containing 1% V: V Triton-X-100 (Sigma-Aldrich T-8787). The samples were spun on a rotating wheel for 1hr at 4^0C and then subjected to 3 freeze-thaw cycles at -20^0C. After centrifugation at 12,000 x rpm, the supernatants were transferred to fresh 1.5ml Eppendorf tubes and 40µl of silica suspension added to recover DNA fragments.

The silica was washed with further GUSCN buffer (0.9 ml x 1), 75% ethanol (0.9 ml x 3) and acetone (0.9 ml x 1) to remove PCR inhibitors and clean the silica. The tubes were thoroughly air dried to remove any solvent residues and then HPLC grade water (65µl) was used to elute DNA at 55^0C on a heated block for 10 mins. The eluates were centrifuged at 12,000 x rpm for 2 mins to ensure removal of silica particles. The extracts were then stored at -20^0C until PCR methods were applied.

Figure 77 Human mandible – indicated are the 1st right pre-molar and left canine that were used for DNA analysis (Thorsten Kahlert).

PCR methods

Mitochondrial DNA (mtDNA)

Two PCR methods were initially used to look for evidence of human mtDNA. Extracts prepared from the tooth were tested using primers which amplify a 116 bp region of the human mitochondrial DNA hypervariable region 1 (HVR-1). The sequences of these primers were:

Forward (L15977-L15998)
5'-CCACCATTAGCACCCAAAGCTA-3' and

Reverse (H16092-H16070) 5'-
ATACATAGCGGTTGTTGATGGGT-3'.

Another variant of this PCR was used with an alternative reverse primer (H16255-H16236) with the sequence 5'-CTTTGGAGTTGCAGTTGATG-3'. In combination with the forward primer, this amplifies a product of 279 bp.

Amelogenin

A gender-determining PCR based on polymorphisms in the amelogenin gene was also applied. In this method, males are identified by two PCR products, one of 105 bp from the Y chromosome and another of 290 bp from the X chromosome, whereas females generate only the one product of 290 bp. The sequences of the primers used in this procedure were (F2) 5'-TGACCAGCTTGGTTCTAWCCC-3' and reverse (R1) 5'-CARATGAGRAAACCAGGGTTCCA-3' [2].

PCR amplification

PCR was performed in a final volume of 15µl using the hot start Taq master kit from Qiagen (product 203445). The reactions contained 15 pmol of forward and reverse primers, each in 1µl, 7.5 µl of the 2x kit master mix, 1.5-µl non-acetylated bovine serum albumin (BSA, Sigma-Aldrich B4287), and 1µl of template. The kit provides a magnesium ion concentration of 1.5 mM per reaction. This was supplemented to 2 mM for the mtDNA methods and to 3mM for the amelogenin PCR. Product formation was monitored in real-time through the addition of EVAGreen intercalating dye (Biotium, from Cambridge Bioscience UK Limited). The volumes were made up to 15 µl with molecular biology grade water (Sigma-Aldrich, W4502). After an initial activation step of 14 min at 95^0C, 43 cycles of amplification were performed on an Mx3005P RT PCR platform (Agilent Technologies, LDA UK Limited). The thermal profiles consisted of denaturation at 95^{0}C for 10s, annealing at 56^{0}C for 30s and extension at 72^{0}C for 30s. Fluorescence data was acquired during the extension step in the PCR runs. Melt analysis was performed automatically at the end of the runs and dissociation curves studied to identify likely positives.

Gel electrophoresis and automated DNA sequencing

PCR products were run out on 3% agarose gels in a TAE buffer system alongside appropriate DNA size markers (100 bp or 50 bp DNA ladders, Promega) to identify expected products by size. To confirm product identity, amplicons were bulk purified on 3% (wt/vol) Ultrapure™ low-melting-point agarose (Invitrogen). Bands were excised and purified using a Geneclean DNA isolation kit (Cat.No.1001-200 from mpbio.com). Templates were sequenced using both forward and reverse primers by Genewiz UK Ltd., Hope End, Takeley, Essex, UK.

Results

mtDNA

Extracts prepared from the cave sample showed the presence of mtDNA template when using the primer pair which generated an amplicon of 116 bp. This is shown in Figure 78. The second combination of primers, which requires survival of templates of 279 bp and above, was unsuccessful, and no product was obtained (not shown) despite the multi-copy nature of mtDNA. The 116 bp amplicon was successfully sequenced with forward and reverse primers. This yielded the sequence:

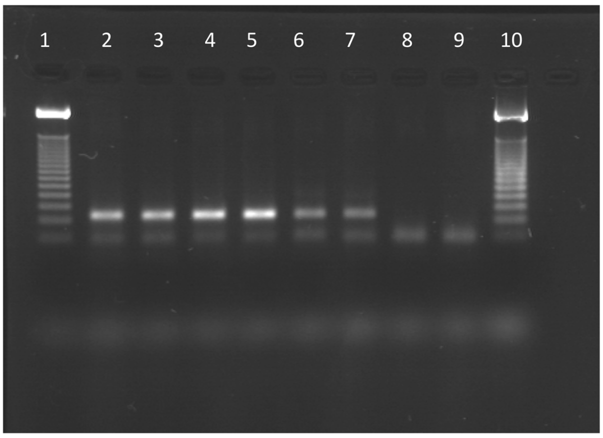

Figure 78 Mitochondrial DNA PCR (116 bp method). Gel electrophoretic separation of products on 3% agarose gel with DNA visualized with SYBR® Safe DNA gel stain. Lanes 1 and 10: 50 bp DNA size markers. Lanes 2 & 3: Extract 1 from Moneen cave tooth sample. Lanes 4 & 5: A second extract from the tooth. Lanes 6 & 7: Unrelated pre-conquest skull fragment from Diss, Norfolk. Lanes 8 & 9: Water blanks.

[1]CCACCATTAGCACCCAAAGCTAAGATTCTAATTTAAACTATTCTCTGTTCTTTCATGGGGAAGCAGATTTGGGTACCACCCAAGTATTGACTCACCCATCAACAACCGCTATGTAT[116].

When input into a BLAST search, this showed perfect matches with multiple human mitochondrial genomes, including the revised Cambridge reference sequence (NCBI Reference NC_012920.1).

Amelogenin PCR

Extracts consistently showed only one band when amplified with the amelogenin method. This appeared to match in size to one of the two bands expected from male individuals, namely 105 bp. There was no indication of the X chromosome product of 290 bp in these experiments (Figure 79). Given the known degraded nature of DNA templates in this case, this would be consistent with a male individual in which only the shorter product could be obtained. This is a pattern which has been observed previously in archaeological material (Waldron *et al.* 1999). Sequencing of this product matched that of the 105 bp band from the known male sample indicating that this was indeed the case. Tentatively, therefore, within the constraints imposed by fragmented DNA survival, we infer this individual may have been male.

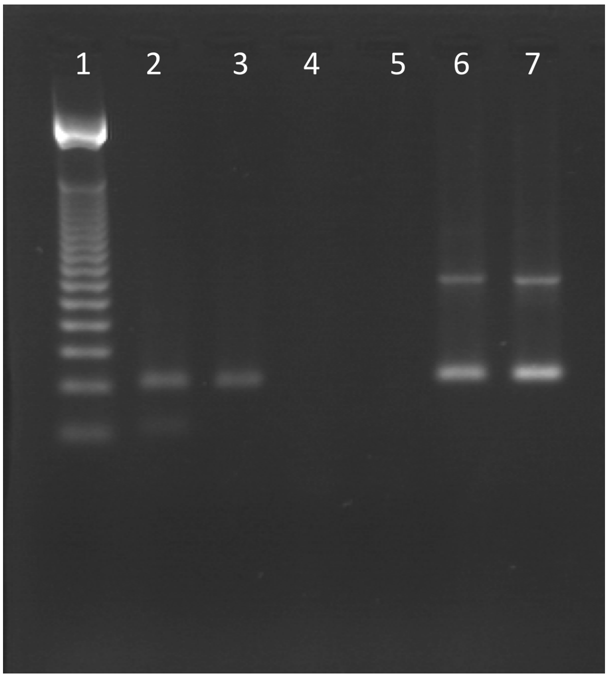

Figure 79 Amelogenin PCR. Gel electrophoretic separation of products on 3% agarose gel. Lane 1: 50 bp DNA size markers. Lanes 2 & 3: single product ca 100 bp obtained from Moneen cave tooth sample. Lanes 4 & 5: Water blanks. Lanes 6 & 7: modern male DNA.

17. Metagenomic analysis and mitochondrial genome reconstruction of the post-medieval individual from Moneen Cave

Åshild J. Vågene, Johannes Krause and Kirsten I. Bos

In the context of post-medieval Christian burial practices in Ireland, the internment of an adolescent individual in Moneen Cave is considered to be non-normative (Garattini 2007; Murphy 2011). Whether this individual was purposefully 'buried' in Moneen Cave or died there circumstantially is not clear from the archaeological evidence (Dowd 2013a). Both scenarios raise questions relating to how this individual's remains came to be located in such a hidden place. One potential reason for the sequestering of this individual's remains could have been infectious disease. Such unusual burial placement may have resulted from an intention to distance this individual from local inhabitants.

Osteological analyses determined this individual to be between 14-16 years of age at the time of death (Section 15). Due to the individual's young age, sex could not be determined using traditional osteological methods. However, previous ancient DNA analyses found this individual to be male (Section 16). No skeletal changes consistent with infectious disease were found on the remains (Section 15); however, the majority of infectious diseases affect soft tissue and do not cause changes to skeletal elements.

In August 2014 a right first maxillary incisor (Figure 82) from the Moneen individual was collected for ancient DNA analyses. The purpose of these investigations was two-fold. First, the microbial DNA content was evaluated and screened for molecular traces of ancient pathogenic microbes that may have infected this individual. Secondly, the mitochondrial DNA (mtDNA) of this individual was reconstructed to determine the mitochondrial lineage, or haplogroup, to which this individual belongs. Mitochondria are multi-copy cellular organelles that have their own genetic makeup, termed mtDNA. Their small circular genome is 16,569bp in length and is only inherited through the maternal lineage. Haplogroups represent the nomenclature used to refer to subsets of mutational variation that exists amongst human mtDNAs.

Methods and results

Sample preparation and sequencing

The incisor was horizontally cross-sectioned at the cementoenamel junction, and 34mg of dentin was drilled from the pulp chamber. The sample was extracted using an established protocol tailored for the extraction of ancient DNA (Dabney *et al*. 2013). The extract was eluted in 100ul TET (10mM Tris, 1mM EDTA, and 0.05% Tween), 10ul of which were converted into a double-stranded DNA-library (Meyer and Kircher 2010), followed by double indexing using a library specific barcode combination (Kircher *et al*. 2012). A portion of the indexed library was further amplified using Herculase II Fusion DNA Polymerase (Agilent) and reactions were suspended before reaching saturation. The amplified indexed library was shotgun sequenced on a HiSeq 4000 lane, producing 21,667,649 single-end reads. Extraction and library blanks were carried along in the experiments, and were also shotgun sequenced.

Data pre-processing

Raw sequencing reads were de-indexed using Illumina's Bcl2fastQ (Illumina). The data from the Moneen individual and the blanks were subsequently processed using a subset of bioinformatics tools integrated in the EAGER pipeline (version 1.92.7) (Peltzer *et al*. 2016). Adapter clipping was done using Clip&Merge, discarding all reads shorter than 30bp (Peltzer *et al*. 2016). The reads were subsequently mapped to the human reference genome (hg19/GRC37) using the Burrows-Wheeler Aligner (BWA) version 0.7.12 (Li and Durbin 2009) to estimate the amount of human endogenous DNA in the library. BWA mapping parameters were customised (seeding turned off, -l 1000; mapping stringency, –n 0.01; quality filter, –q 30) to accommodate the characteristic deaminated bases that occur towards the ends of ancient DNA fragments. Duplicate removal was done using MarkDuplicates from the Picard toolkit (http://broadinstitute.github.io/picard/). In order to separately analyse mitochondrial reads and to determine the individual's haplogroup, clipped reads were mapped separately to the human mitochondrial genome reference (rCRS) (Andrews *et al*. 1999). The same method and parameters as outlined above were applied, with the exception that Circularmapper (Peltzer *et al*. 2016) was used in place of BWA, in order to retain the genetic information at the ends of the reference that would otherwise be lost in linear mapping.

Given the number of mapping reads using the above approach, it is estimated that the library has approximately 8% human endogenous DNA, and ~0.027% endogenous mtDNA when mapped only to the human mitochondrial genome. Human mitochondria exist in high copy number and have very small genomes compared to the nuclear genome. Even though there is only 0.027% endogenous mtDNA in the sequenced reads, this yields a mean mitochondrial coverage of 14.5-fold, with 99.11% of the reference

Reference	Total raw reads	Mapped reads after duplicate removal	Endogenous DNA (%)	Mean coverage (fold; X)	Average fragment length (bp)	Reads with damage on 1st base 5-prime (%)	Reads with damage on 2nd base 5-prime (%)	Initial contamination estimate (%) (low, high)	Final contamination estimate (%) (low, high)
HG19 (complete human genome)	21667649	1543204	8.213	0.0255	51.12	0.1086	0.0648	n.a.	n.a.
rCRS	21667649	4223	0.027	14.5	56.83	0.1314	0.0935	0 (0, 0.5)	1(0, 2)

Figure 80 Mapping statistics (Peltzer *et al.* 2016), mapDamage (Ginolhac *et al.* 2011) deamination values and Schmutzi (Renaud *et al.* 2015) contamination values for the mtDNA.

covered at least 5-fold (see Figure 80). The blanks are negative for both modern and ancient human DNA, indicating that the reagents and work environment used during extraction and library preparation did not contribute a significant amount of human contaminant DNA to interfere with downstream bioinformatics analyses.

Deamination pattern and ancient DNA authenticity

Ancient DNA degrades over time into increasingly shorter fragments. The terminal ends of the resulting fragments are vulnerable to chemical damage, and deamination of cytosines accumulates at the 5-prime end of the molecules. In the sequencing data such damage is evidenced by an accumulation of C to T transitions at the ends of molecules, which can in turn be used to authenticate molecules as ancient as opposed to modern contamination (Sawyer *et al.* 2012).

The bioinformatic tool mapDamage (Ginolhac *et al.* 2011) was used to calculate the deamination pattern of the mapping reads to both hg19 and the human mitochondrial reference. As single-end data were produced, only the deamination pattern reported for the 5-prime ends of the reads can be reliably estimated. Deamination rates for the 5-prime ends of the mapped reads were 10.8% and 13% for reads mapped to the human reference genome and the mitochondrial reference sequence, respectively (see Figures 80 and 81). Radiocarbon dates indicate that the Moneen individual lived during the 1500-1600s (Dowd 2013a). The deamination rates are relatively low, indicating good DNA preservation. A contributing factor may be the lower temperatures in Ireland, as heat is known to increase the degradation of ancient DNA (Sawyer *et al*. 2012), and also the fact that cave environments are usually quite stable.

Contamination estimate and consensus calling

Schmutzi (Renaud *et al*. 2015) is a tool that uses an iterative approach to estimate the degree of mitochondrial contamination within a sample. Putative contaminant reads are identified and removed, and consensus sequence of the endogenous mitochondrial genome is produced. Reads mapping to the mitochondrial genome were predicted to have a contamination estimate of 0% after the first iteration. The final iteration gave a contamination estimate of around 1% after removal of mapping reads that deviate from the expected length, deamination pattern, and base calls (Renaud *et al*. 2015). This is a low level of contamination. A database of present-day Eurasian mitochondrial genomes accompanying the Schmutzi software was used as a reference for identifying contaminant sequences.

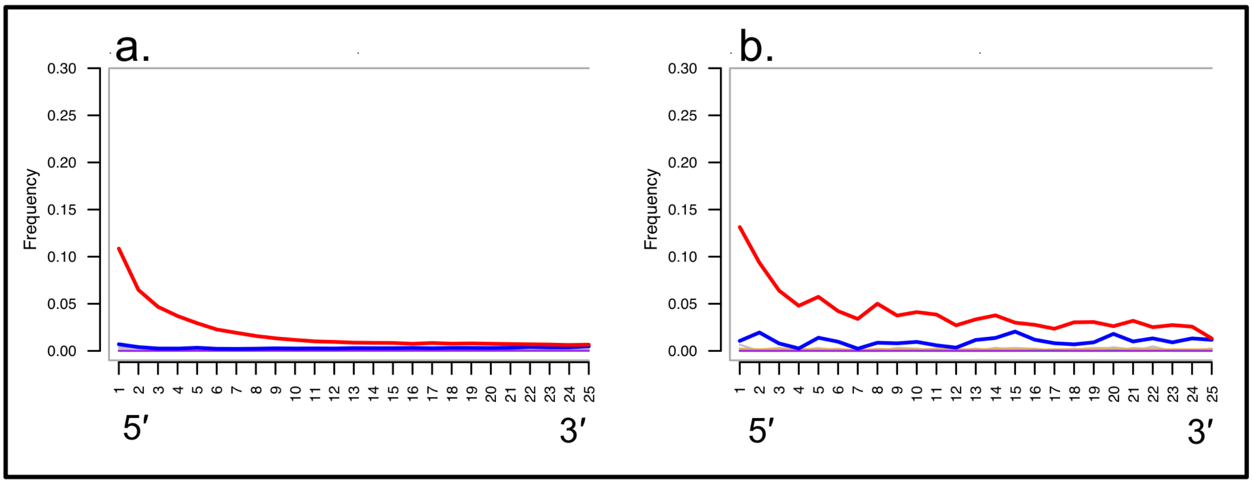

Figure 81 mapDamage (Ginolhac *et al.* 2011) curves depicting the deamination pattern of reads produced from sequencing the Moneen individual, mapped to a) the human genome, b) the rCRS (mtDNA). The curves depict the frequency of deaminated bases occurring towards the terminal 5-prime ends of mapped reads.

The reads remaining after the final iteration of Schmutzi were used to generate a consensus sequence based on the endogenous DNA of the Moneen individual. A quality filter of -q 20 was applied to the final endogenous consensus sequence output from Schmutzi, resulting in 34 out of 16,569 positions not being sufficiently covered to facilitate a consensus call. The quality-filtered consensus was used to determine the Moneen individual's mitochondrial haplogroup.

Haplogroup assignment

Using Haplogrep 2.0 (van Oven and Kayser 2009; Weissensteiner *et al*. 2016) it was determined, based on the quality filtered Schmutzi consensus sequence, that the mitochondrial genome of the Moneen individual belongs to haplogroup J2b1b1. The following positions in the mitochondrial genome of the Moneen individual contribute to its haplogroup assignment: 73G, 263G, 489C, 750G, 1438G, 2404C, 2706G, 4216C, 4769G, 5633T, 6962T, 7028T, 7211A, 7476T, 8860G, 10172A, 10389C 10398G, 11251G, 11719A, 12612G, 13708A, 14766T, 15257A, 15326G, 15452A 15812A, 16069T, 16126C and 16193T. This individual also had one hotspot mutation located in the control region of the mtDNA: 16519C.

Sex determination

The reads mapped to the human reference genome were used to determine the sex of the Moneen individual using an established method (Skoglund *et al*. 2013), which compares the ratio of reads mapped to the X chromosome versus the Y chromosome. The result indicates that the Moneen individual is male with a 95% confidence interval for R_Y of 0.0844-0.0896, thus confirming the result of previous ancient DNA analyses (Section 16).

Metagenomic analysis using MALT

MALT (**M**egan **AL**ignment **T**ool) (Herbig *et al*. 2016) is a rapid sequence alignment tool based on a binning algorithm that uses a reference database – in this case one consisting of all publicly available complete bacterial genomes and plasmids (NCBI RefSeq, December 2015) and eukaryotic organelles (NCBI RefSeq Organelle Genome Resources, February 2016) – to assign sequence reads to the taxa/genus/species where they align best. MALT is specifically designed to produce an output compatible with visualisation in the metagenomic analysis software MEGAN (Huson *et al*. 2007; Herbig *et al*. 2016). MALT (version 0.1.2) was run twice using 'SemiGlobal' alignment, with 100 set as the maximum number of alignments for each read and allowing 64 threads/CPU cores. The following parameters were set for the taxonomic assignment: *top percent* was set at 1.0 and *min support percent* at 0.01. The minimal percent identity of aligned reads included in the output of the analysis was set to 85% and 95% respectively for each run. In both cases ancient oral and environmental bacteria dominated the microbial content of the sample.

No traces of DNA belonging to pathogens that cause systemic disease were identified. Several species of bacteria belonging to the oral microbiome were identified from the MALT results. In the MALT output run with the minimal percent identity score set to 95%, the five most numerous bacterial species were: *Capnocytophaga ochracea*, *Streptococcus gordonii*, *Tannerella forsythia*, *Rothia dentocariosa* and *Streptococcus sanguinis*. These bacteria are commonly known to be part of the human oral microbiome (Chen *et al*. 2010).

Discussion and concluding remarks

Mitochondrial haplogroup J is found to be present in Europe and the Near East (Logan 2008; Pierron *et al*. 2011). In Ireland alone, based on modern data, haplogroup J occurs at a frequency of around 10.7% (mtdna.eu). Haplogroup J has two major sub-haplogroups, J1 and J2, where J1 is more commonly represented in Europe and the Near East than J2 (Pierron *et al*. 2011). There is limited information about the specific sub-haplogroup of J2b1b1 that the Moneen individual belongs to. At least four individuals belonging to mitochondrial haplogroup J2b1b have been entered into the Family Tree DNA database (https://www.familytreedna.com/public/J-mtDNA/default.aspx?section=mtmap), one of which is from Northern Ireland, two from Scotland and one from England. In all, the haplogroup assignment of J2b1b1 indicates that the Moneen boy has European maternal ancestry. Further genetic analysis concentrating on autosomal loci would be required to gain a more detailed picture of this individual's genetic ancestry.

Individuals with Leber's hereditary optic neuropathy (LHON), a maternally inherited genetic disease that causes blindness and deafness, has been linked to individuals belonging to haplogroup J, specifically J1c and J2b (Achilli *et al*. 2012). There are three major point mutations that are highly associated with this disease that occur in the mitochondrial genome (Achilli *et al*. 2012). The mtDNA of the Moneen individual was checked for the presence of these LHON associated point mutations, and none were present.

The location and preservation of ancient pathogen DNA in skeletal remains is highly variable depending on the pathogen in question (Bos *et al*. 2014; Kay *et al*. 2014; Schuenemann *et al*. 2013). As the skeletal remains of this individual did not display any changes consistent with known diseases, the best chance of recovering ancient pathogen DNA was the pulp chamber of the tooth in the hope of finding blood borne pathogens whose DNA may have been preferentially protected by the hard enamel coating. Based on the DNA that was extracted, we found no trace of bacterial or eukaryotic pathogens that could have caused a lethal infectious disease. The MALT database, however, does not include viruses. Although responsible for many diseases, a large number of viruses are made up of molecularly unstable RNA, and are thus highly unlikely to be preserved in skeletal remains found in the archaeological record. The viruses that cause smallpox and chickenpox, however, have genetic material made of double stranded DNA. The presence of DNA from either of these viruses was investigated in the sequencing data using the mapping approach outlined above. Zero reads mapped to either virus.

We were not able to detect any pathogens that could be responsible for the death of this boy. However, the preservation of ancient pathogen DNA is not guaranteed, and therefore our negative findings do not wholly exclude the scenario that this individual may have died due to an infection.

Acknowledgements

The authors would like to thank Cosimo Posth, Alissa Mittnik, Alexander Peltzer and Wolfgang Haak for fruitful discussions and advice regarding data analysis.

18. Isotopic analysis of the human skeletal remains

Thomas Kador

One human tooth and three animal teeth were submitted for isotopic analysis. The human sample was a left maxillary 2nd molar extracted from the maxilla jawbone that had been found by cavers (C.0X) (Figure 82). The faunal samples included a goat molar from C.6 and two rabbit/hare incisors. It is likely that all three sampled animal teeth were from relatively recently deceased remains.

The human sample was analysed for strontium, oxygen and carbon isotopes – and the animal samples served for comparison purposes. These isotopes were analysed in dental enamel. For this, a sample of 25.5mg (16.8mg for strontium and 8.7mg for oxygen) was taken from the human tooth. Unfortunately, both the oxygen and strontium analyses on the goat molar failed (Figure 83), probably because the enamel was substantially worn down and quite possibly compromised. It was felt that there would be little purpose in sampling the rabbit/hare teeth for oxygen and carbon analysis, as the relationship between drinking water and oxygen isotopes in small mammals is much less well understood than for humans and other large mammals (Bentley and Knipper 2005; Chenery *et al*. 2012: 315). Therefore, these samples would not provide a useful comparison.

Figure 82 Human left maxillary 2nd molar used for isotopic analysis, and right maxillary 1st incisor used for pathogen screening (Thorsten Kahlert).

Methods and analysis

Strontium ($^{87}Sr/^{86}Sr$) isotope analysis was carried out at the Bristol Isotope Group (BIG) laboratory at the School of Earth Sciences, University of Bristol. The enamel samples were dissolved in nitric acid, and strontium was separated from the solutions by ion exchange chromatography using Eichrom Sr-Spec resin (Horwitz *et al*. 1992). The dried down samples were then loaded onto rhenium filaments and measured on a Thermo Triton Thermal Ionization Mass Spectrometer (TIMS) and corrected to a $^{87}Sr/^{86}Sr$ value of 0.710248 for carbonate standard SRM 987 (Kador *et al*. 2015; Triantaphyllou *et al*. 2015). Internal precision for $^{87}Sr/^{86}Sr$ isotope ratios is typically ±0.00001.

The oxygen isotope ($d^{18}O$) analysis was conducted at the NERC Isotope Geosciences Laboratory (Keyworth, UK). Oxygen isotopes were measured in the structural carbonate following the method published by Chenery *et al*. (2012: 310). The enamel samples were ground to a powder in an agate mortar and then weighed into glass vials, which in turn were sealed with a septa. The vials were heated and evacuated (on a GV Instruments Multiprep system) before anhydrous phosphoric acid was added. This released CO_2 which was then measured in a GV IsoPrime dual inlet mass spectrometer. The results are reported as per mil ($\%_o$ $^{18}O/^{16}O$) relative to Pee Dee Belemite (PDB) carbonate standard, based on NBS19 certified reference material (Chenery *et al*. 2012: 310). To allow broader comparison, the values are also reported relative to Standard Mean Ocean Water (SMOW) based on the published conversion equation of Coplen (1988) (SMOW=1.03091_d18O PDB + 30.91). Measuring oxygen ratios on the carbonate like this also provides $d^{13}C$ ratios – i.e. the ratio of ^{13}C to ^{12}C isotopes, which again are published relative to PDB carbonate standard (Bentley and Knipper 2005: 632).

Results and interpretation

In simple terms, the ratio between the strontium isotopes 87 and 86 (expressed as $^{87}Sr/^{86}Sr$) relates to the geology

(Bentley 2006) – based on the make-up, and especially the age, of the underlying bedrock. The d^{18} oxygen ratio ($d^{18}O$) relates to climate, in particular rainfall (Evans *et al*. 2010), and the $d^{13}C$ result broadly relates to diet. More specifically, $d^{13}C$ can tell us about the likely marine contribution to the measured individual's diet (Schulting and Richards 2000). The results of the analyses are summarised in Figure 83.

For additional comparison, the results from strontium analysis from the three successful Moneen samples were charted against the recently obtained results from two independent studies on Neolithic human remains from Poulnabrone portal tomb (Ditchfield 2014; Kador *et al*. 2015) (Figure 84). As this site is located only approximately 6km due south of Moneen Cave as the crow flies, it should provide broadly comparable strontium isotope results, if the remains were local to the region. Despite the significant chronological difference between the post-medieval individual from Moneen Cave and the Neolithic remains from Poulnabrone, it is presumed that environmental factors did not severely affect strontium isotope results in humans until at least the mid-1800s (Bentley 2006; Montgomery 2010).

As can be seen from Figure 84, there is a better match between the results from the Moneen human remains and those from Poulnabrone, especially Poulnabrone 2, than with the rabbit/hare samples collected from Moneen. This could perhaps be due to somewhat differential absorption of strontium between humans and small mammals, or differential diagenetic processes. Furthermore, the rabbit/hare samples were identified as being recent (Marion Dowd pers. comm.) and therefore it is possible that pollution (e.g. through fertiliser) played a part in their strontium values (Bentley 2006). Overall, the three successful samples from Moneen Cave and the averaged results from the two Poulnabrone studies are very close together (within 3.0E-4) and match closely with the values we would expect for the karstic limestone of the Burren (Ditchfield 2014; Evans *et al*. 2010; Kador *et al*. 2015).

To highlight this further, the strontium isotope results from Moneen and Poulnabrone were charted against those from other recently analysed human bones from Irish caves (Figure 85), though once again these are all much earlier in date and relate to prehistoric activities (Kador *et al*. 2015). Although a very small sample, we can clearly see that there is significant strontium variation across prehistoric human remains from Irish caves, yet how closely the three Moneen samples (i.e. one human and two rabbit/hare teeth) and the averaged Poulnabrone results sit together.

Unfortunately, when it comes to oxygen isotopes there are fewer studies with which to compare the results from Moneen. Ditchfield (2014) analysed the remains from Poulnabrone portal tomb for both strontium and oxygen, so they provide a useful comparison from a site in close geographical proximity. Further afield, we can compare the results to the recently analysed human remains from the Neolithic passage tomb complex at Carrowkeel, Co. Sligo (Kador *et al*. forthcoming). However, as outlined above, the oxygen isotope ratio relates to climate and especially rainfall, and while the geology of the Burren (as broadly reflected in the strontium ratios) may not have changed significantly between the Neolithic and the post-medieval period, the climate and levels of precipitation certainly did change (Koch 1998). Therefore, comparing oxygen isotope results from a 16th/17th century individual with those from Neolithic individuals is more problematic than doing so for strontium values. Thus, for additional comparison purposes I have drawn on two recently published late Iron Age/early medieval burials from county Galway – both extended inhumations of women. The Ballygarraun burial was dated to AD 432-661, and the Farta burial was dated to AD 383-536 (Cahill-Wilson and Standish 2016: 233-4).

Figure 86 charts the strontium against the oxygen results from Moneen and the other four locations mentioned above. From this we can see that the two Iron Age/early medieval samples from Galway are much closer to the Moneen remains in terms of oxygen isotope ratios. What is most striking is the close match between the tooth from Moneen and that from the Farta burial. Farta is located just north of Loughrea and some 41km northeast of Moneen Cave. East Galway, like most of central Ireland, also lies within a limestone area dominated by Carboniferous limestone, which appears to be reflected in the close match in strontium values between Farta and those from the human remains from Moneen Cave and Poulnabrone. Interestingly, however, Cahill-Wilson and Standish (2016: 238) have interpreted the Farta and Ballygarraun burials as 'non-local based on $d^{18}O$ values too low for western Ireland'. Yet in the present study, there is a very close match between these burials and the remains from Moneen in terms of the oxygen values

		$^{87}Sr/^{86}Sr$	Std Error	$d^{13}C$ PDB	$d^{18}O$ PDB	$d^{18}O$ SMOW
MN01	Human	0.708827	4.06E-06	-15.40	-4.35	+26.44
MN02	Goat	Failed	Failed	failed	Failed	failed
MN03	Rabbit/hare	0.708563	3.20E-06	N/A	N/A	N/A
MN04	Rabbit/hare	0.708597	3.24E-06	N/A	N/A	N/A

Figure 83 Strontium, oxygen and carbon isotope results from the Moneen samples

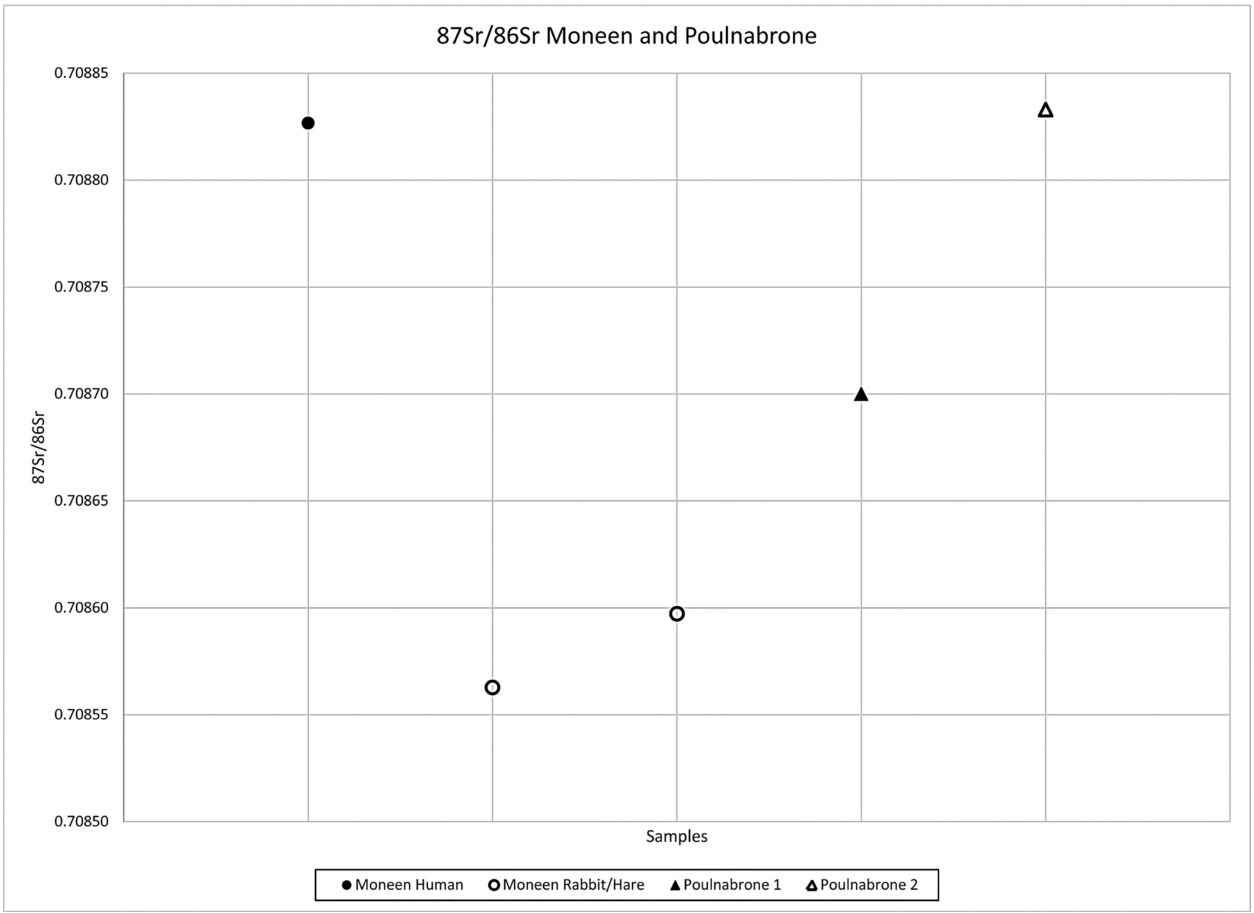

Figure 84 Strontium analysis results for three samples from Moneen in comparison to values from Poulnabrone. Sources: Poulnabrone 1, Ditchfield (2014); Poulnabrone 2, Kador *et al.* (2015).

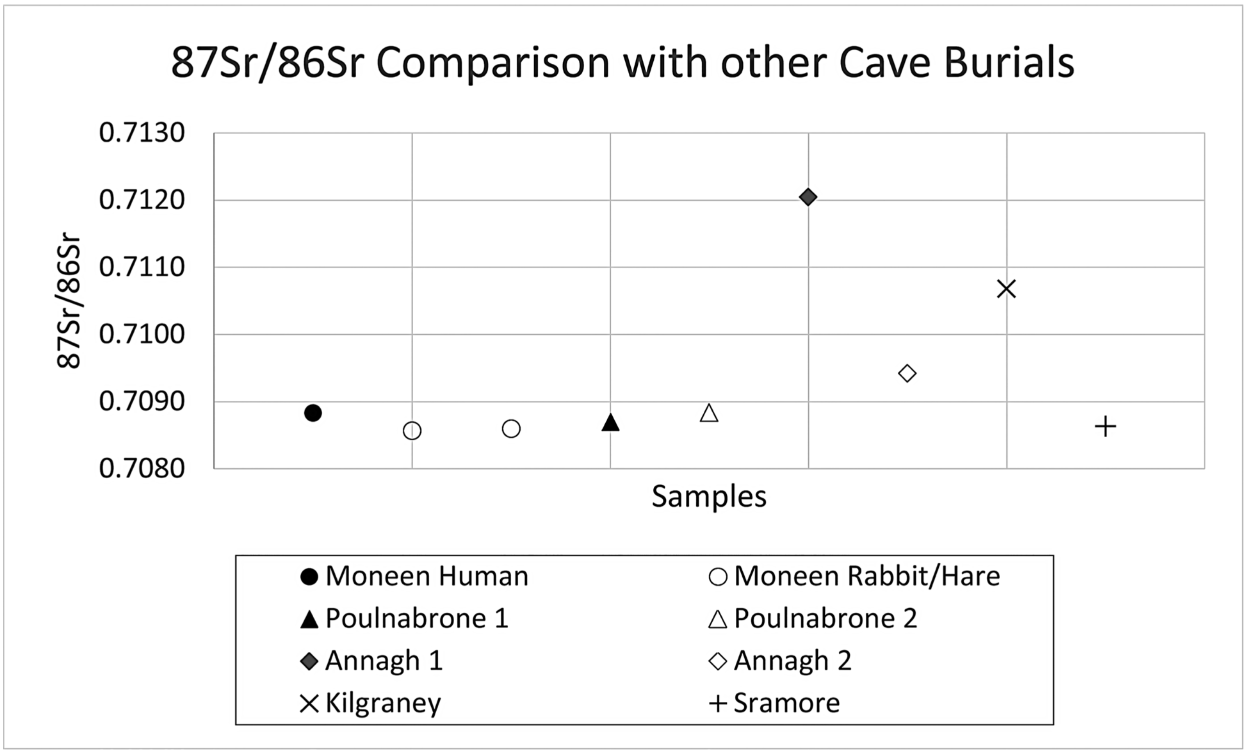

Figure 85 Strontium isotope ratios from Moneen, Poulnabrone and other Irish caves.

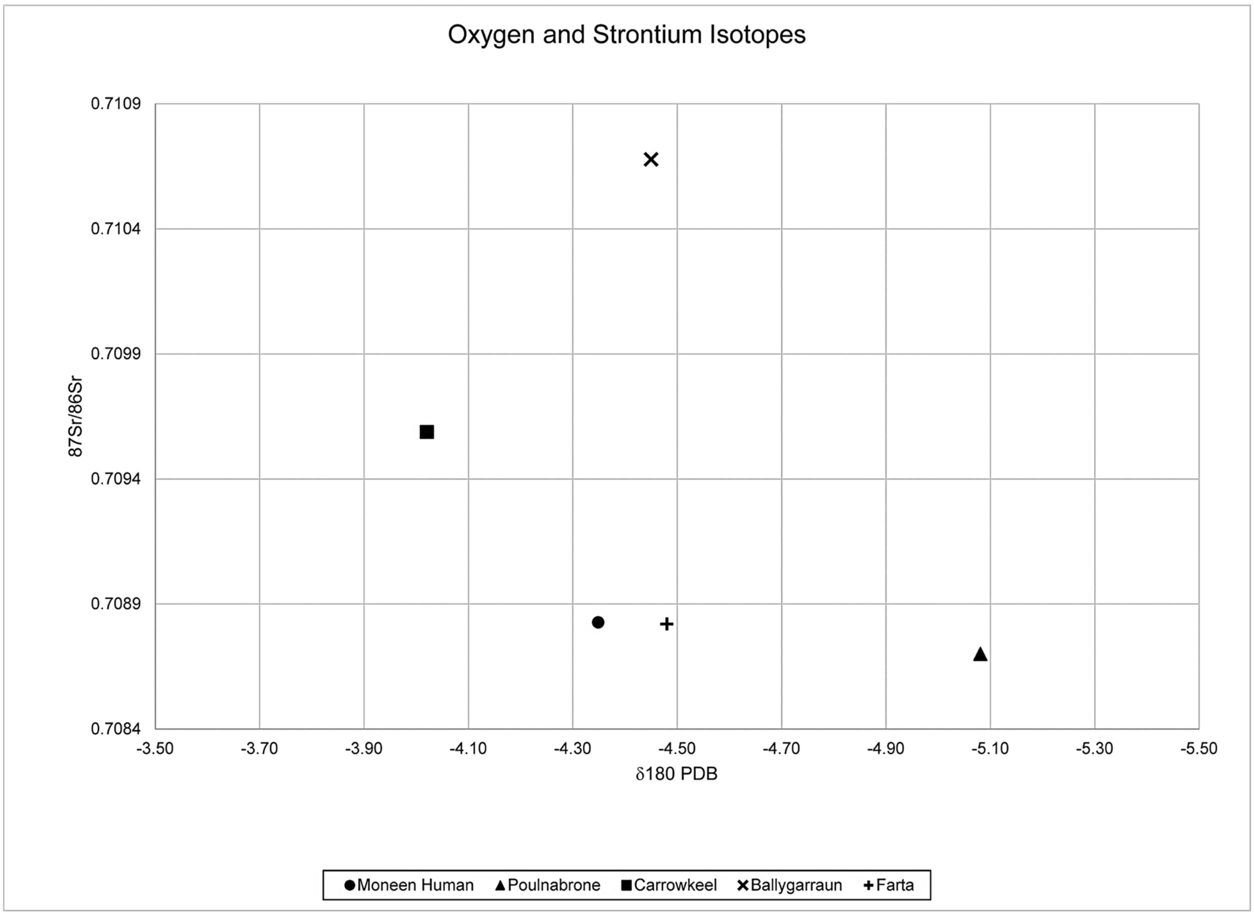

Figure 86 Strontium and oxygen ratios for human bones from Moneen Cave, Poulanbrone (1) portal tomb, Carrowkeel passage tomb, and the Ballygarraun and Farta inhumations.

(and also the strontium for Farta), and the fact that the average oxygen values from Poulnabrone are even lower. Therefore, notwithstanding the above mentioned caveats regarding climate change and oxygen isotopes, the analysis results would suggest that it is most likely that the young male found at Moneen Cave was local to the Burren or its immediate surroundings.

19. Analysis of Growth Recovery Lines (Harris lines) in the human skeletal remains

Fran O'Keeffe

Growth Recovery Lines (GRL), or Harris lines as they are more commonly known in the archaeological literature, are transverse radiopaque bone lines seen on radiographs (Harris 1931). In reality, however, as evident from sectional imaging, they represent thin sections of the bone cylinder rather than lines. They are most often seen in the growing ends of long bones, especially the femur and tibia, which contribute most substantially to overall bone growth. Clinical and experimental studies have shown that lines can result from a variety of stresses causing growth disturbance (Alfonso-Durruty 2011; Ogden 1984). Their formation occurs during growth recovery after a period of growth arrest. After dietary deprivation and restoration of normal diet, for example, lines develop (Siffert and Katz 1983). While some authors contend they may coincide with 'normal saltatory growth' patterns (Alfonso *et al*. 2005), this does not explain why they occur with considerably greater frequency in medieval populations characterised by short stature (Ameen *et al*. 2005; Jaewon *et al*. 2014). Furthermore, Harris lines in a high social status Korean medieval population, although more frequent than in their modern counterparts, have been shown to be considerably less frequent than in contemporaneous medieval populations of lower social status – likely related to the different nutritional status of these groups (Jaewon *et al*. 2014).

Accordingly, Harris lines are accepted as markers of disturbed bone growth and a useful adjunct in assessing the health of an individual. The number of lines reflects the level of individual stress. Small distances between lines in one individual may reflect several causal factors in a single year (Krenz-Niedbala 2001). Animal models suggest an initial period of growth suppression and subsequent recovery is necessary for their development, and this has led to their designation also as Growth Recovery Lines (GRL) (Siffert and Katz 1983).

Histologically, lines represent disks of transversely oriented, as opposed to the normal longitudinally oriented, bony trabeculae. They form due to a relative slowing of cartilage conversion to bone but continued mineralization of the developing metaphyseal trabeculae (Ogden 1984). With the resumption of normal growth, the physis (growth plate) migrates away from the line which remains in the metaphysis. If physeal activity is uniform, the GRL will continue to be parallel to the physis as growth progresses (Ecklund and Jaramillo 2001).

Each line position denotes the time of disrupted growth and, when the sequence of bone increments during the process of growth is known, the distance of a Harris line from the adequate end of a bone allows estimation of the age of the individual at the time of formation (Byers 1991; Hummert and Van Gerven 1985). There are some potential pitfalls with this approach. The lines may resorb a few years after formation (Goodman 1981). That Harris lines resorb has long been established from longtitudinal observation in living populations and this process appears due to cortical remodelling both endosteally and subperiosteally (Garn and Schwager 1967). There may be different numbers of lines in different bones. Peaks of line formation appeared to correspond to periods of rapid growth in the process of ontogeny (Krenz-Niedbala 2001). Accelerated growth in the process of ontogeny occurs in infancy and between 3-6 and 11-12 years of age. During these periods long bones are especially susceptible to stress and Harris lines are usually most frequent in these age intervals. The first period of accelerated growth is in infancy and early childhood, and Harris lines formed during this period may resorb and disappear (Nowak and Piontek 2002). Regular occurrence of Harris lines in the form of annual sequences were seen in these two prehistoric populations (Krenz-Niedbala 2001)

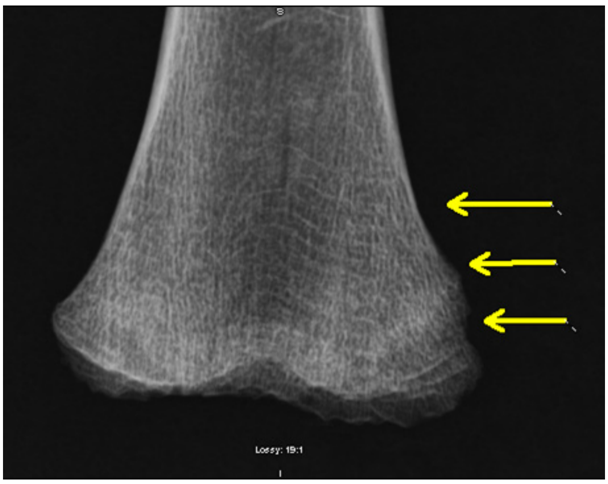

Figure 87 Distal femur anteroposterior radiograph. Multiple Harris lines parallel to distal femur indicated.

Analysis of Harris lines in the Moneen Cave skeleton

Digital radiographs were taken of the upper and lower limb long bones and the pelvis. Harris lines were seen in the tibiae, femorae and fibulae. The lines were multiple in number and most numerous in the knee region involving the distal femur and proximal tibiae (Figures 87 and 88). The number of lines was greatest in the proximal tibiae, distal femorae and right proximal fibula (between 12 and 15 lines). The preponderance of lines in this region corresponds with the importance of both these bones in their contribution to overall bone growth with the most rapid bone growth occurring here. The lines were all parallel to each other and to the physeal contour (this contrasts with distorted/angulated growth lines seen after local growth plate damage as with fractures). No associated osseous findings were seen in the imaged bones. In particular, no periosteal reaction and no abnormal bone curvature was noted (e.g. no evidence of rickets).

Age at line formation was determined using the method described by Hummert and Van Gerven (1985) for sub-adult bones. This involves measuring the total bone length (in this case tibiae were used) and the distance of the Harris line from the primary centre of ossification. The primary centre of ossification position can be determined knowing the appropriate percentage contribution to total bone growth (e.g. 43% for distal tibia and 57% for proximal tibia). These measurements were then used to

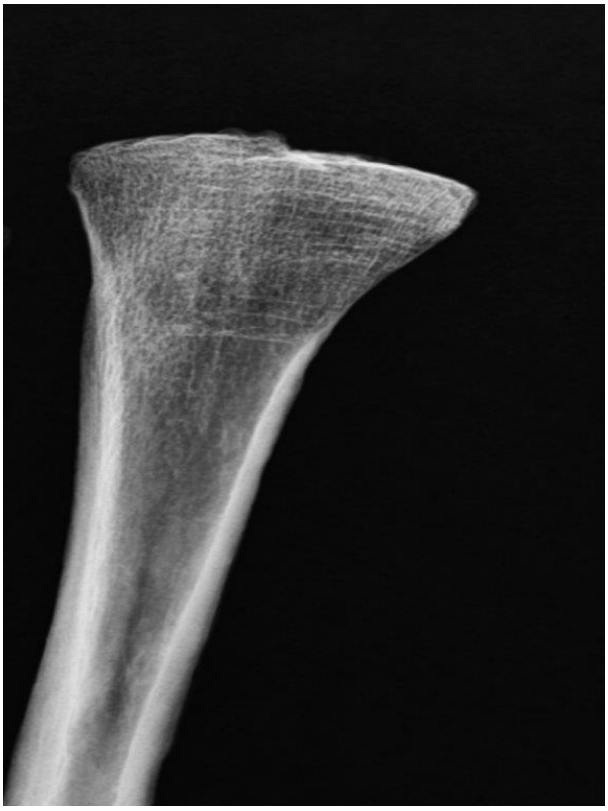

Figure 88 Proximal tibia anteroposterior radiograph showing multiple Harris lines.

calculate the percentage of mature bone length at the time of line formation. The specific ages of Harris line occurrence were then estimated using tables of limb bone growth chronology (Hummert 1983).

In the Moneen Cave skeleton, approximately 12 Harris lines in the proximal tibiae formed over 8-9 years. The lines were formed between the ages of 5 and 16 years approximately. The lines were more numerous over the latter 5-7 years, i.e. when the boy was approximately 9-16 years old.

Discussion

The occurrence or appearance of Harris lines does not indicate or distinguish a specific limiting cause (Nowak and Piontek 2002). Peaks of frequency may parallel normal growth spurts (Alfonso *et al*. 2005), but this seems very unlikely in the case of the Moneen Cave individual given the individual's markedly short stature even by medieval standards (Section 15). There is a considerable body of evidence to suggest that lines form in response to a wide variety of stressful stimuli, especially chronic or repeated stress. Consequently, analysis of the likely stress factors pertaining during the lifetime of this individual is required. There may be perhaps peculiar circumstances relating to the final location. Possibilities include malnutrition, infections and psychosocial stress such as warfare and social disruption (Gindhart 1969; Khadilkar *et al*. 1998; Park 1964). While primary growth hormone deficiency has also to be considered a possible cause of short stature here (Section 15), it is significant that Harris lines are not a feature of this condition. This has been attributed to constant lack of growth in hypopituitary patients as opposed to the fluctuating environment pertaining to other stresses/insults (Hernandez *et al*. 1978; Khadilkar *et al*. 1998). It is certainly tempting to speculate that poor health, nutritional deficiencies and/or infection are the most likely contributory factors to the Harris lines in the Moneen Cave skeleton based on the evidence from other medieval populations. A considerably higher incidence of Harris lines have been noted in medieval populations than contemporary ones, presumed to reflect different living conditions, dietary factors and hygiene/infection (Ameen *et al*. 2005). The extent and multiplicity at Moneen Cave suggest likely chronic repetitive insult, as many lines develop if insult(s) are repetitive, with those closest to the growth plate being of recent origin and those furthest away being older. The period of time over which they formed was at least 10-11 years and it would seem likely that they formed throughout his life given that those formed in infancy and early childhood may well have resorbed as described in skeletal populations of different time periods (Hummert and Van Gerven 1985)

Other non-specific skeletal indicators of physiological stress have been well documented in the archaeological literature (e.g. McKenzie and Murphy 2011) including porotic hyperostosis, cribra orbitalia and dental enamel hypoplasia. A relationship between Harris lines and some of these (for example, dental enamel hypoplasia and cortical bone thickness) has been documented in medieval skeletons (Alfonso *et al*. 2005; Mays 1995). The presence of porotic hyperostosis in the Moneen Cave skull would support the contention that dietary factors or malabsorbtion (the only caveat is that there is no radiographic or other evidence of rickets) may have contributed to short stature.

20. Historical context of the adolescent boy from Moneen Cave

Ciarán Ó Murchadha

At first sight the skeletal remains of a teenage boy from Moneen Cave seem to present insurmountable obstacles in terms of documentary evidence (virtually none), and the loosest date parameters only (virtually the entire early modern period), within which to place his existence. On the other hand, it is precisely these obstacles that make the Moneen Cave discovery so intriguing and, once we have accepted that we can know so very little of the boy personally, such a challenge to our resourcefulness in furnishing some kind of context for his life. Any attempt at doing so, of course, rests on two fundamental and reasonable assumptions: that the boy was local to the district where his remains were found, and that he was fully *compos mentis* and not a sufferer from intellectual disability that might have been a factor in the isolation in which he clearly died. But even if these assumptions are incorrect, much of what follows still stands.

Our starting point lies in the 'findspot' for the remains, which is in Acres townland, just metres from its boundary with Dangan immediately to the south, both townlands lying in the civil parish of Drumcreehy and barony of Burren. The cave is referred to as Moneen Cave because it is landmarked by Moneen Hill nearby; Moneen townland in fact is a slight distance away in Abbey parish. The configuration of Acres and Dangan in the Ordnance Survey Townland Index Sheets suggests that both were once part of a larger unit, a supposition that is confirmed by the seventeenth century cadastral record known as the *Book of Survey and Distribution*, where Acres is referred to as Dangan Upper (actually rendered 'Dangian', it included two other denominations which are now separate townlands) (Simington 1967: 478). As to Drumcreehy parish itself, it is one of eleven civil parishes in Burren barony, the northernmost division of Clare, as the Gaelic territory of Thomond (Tuadhmumhan) began to be known as English-imposed administrative structures began to take hold towards the end of the sixteenth century (Flynn 1993: 56; O'Mahony 2004: 45-6). In the boy's lifetime, whether we prefer an early sixteenth century or a late seventeenth century date for it, or any point in between, Drumcreehy was an ecclesiastical as well as an administrative unit, and the boy would have known its parish church, now a ruin in nearby Bishopsquarter, as a place of worship. It is quite possible that he worshipped there.

O'Donovan renders Drumcreehy as *Druim Críche* in Irish, or the Ridge of Críoch, portion of the ancient territory of Críoch Máille, and it was as *Druim Críche* that the boy, monoglot Irish speaker that he certainly was, would have known the place (O'Donovan and O'Curry 1997: 25). He would have been familiar with the Irish version of the parish's other townlands, and necessarily would have had a deeper understanding of the purport and meaning that we do of its placenames as they are known to us: Ballycahill, Ballyconry, Ballyvaghan, Bishopsquarter, Killoghil, Knocknagroagh, Lisnanard, Loughrask, Muckinish East, Muckinish West, Newtown and Tonarussa (*General Alphabetical Index to the Townlands and Towns, Parishes and Baronies of Ireland* 1861).

The boy would have known intimately the lie of the parishes surrounding Drumcreehy, as also their internal places, and as an overlay on this defining grid on his geographical consciousness there was also the ecclesiastical/administrative division constituted by the Diocese of Kilfenora, which was coterminous with the baronies of Corcomroe and Burren. Corcomroe Abbey, with its own ramifications, religious and jurisdictional, would also have loomed large in his awareness, either as a functioning Cistercian foundation if he knew it in the sixteenth century, or as a ruin resonant of historic spirituality if he knew it in the seventeenth.

As he went about his daily round, the boy would have registered in his mind the standing remains that still litter the landscape of the north Burren. In most cases, much as we do, he would have done so unthinkingly, or perhaps accorded them certain spiritual-mythological significances that have been diluted in the folk memory of later times, or are now lost. On the other hand, he would have had a high level of awareness of the stone structures in use in his own time, and apart from the ecclesiastical structures, would have had a particular appreciation of the four stone 'castles' or towerhouses in Drumcreehy parish: the long-vanished castle of Ballyvaughan, the castles of Shanmuckinish and Muckinishnoe, and the unusually shaped castle at Newtown (O'Donovan and O'Curry 1839). He would have had a high level of apprehension with regard to those to whom they belonged, or had once belonged – the clan dynasts of the Uí Lochlainn, the so-called princes of Burren.

If he lived at any time in the sixteenth century, the boy would have experienced the power and presence of the Uí Lochlainn as a living reality; would have known and been intimidated by the weight and power of their lordship, minor sept though they were; the full panoply of their learned classes; their brehons, gallowglasses, poets, clerics, musicians and reciters; the catalogue of their tributary clans; and the rights and privileges they exercised among those whom the English referred to as 'freeholders'. He would have been aware of the proud open-handed giving of the ruling Ua Lochlainn, and the great herds and flocks that contained his wealth, and from which so much of his largesse would have been dispensed.

If he lived in the late seventeenth century, on the other hand, the phenomenon of Uí Lochlainn greatness would have been a memory only to the boy; an inherited memory indeed if he had not been old enough to witness at first hand the disintegration of the clan in the calamities of the mid-century. He would not then have realised that the fortunes of the Uí Lochlainn had in fact been on the decline for much longer, indeed almost continuously across the centuries of the medieval period (Ó Corráin 1975: 21). Together with their kindred, the Ui Conchúir of neighbouring Corcomroe barony, the other branch of the historic Corcú Modruadh, for centuries they had striven in vain to contain the relentless northwards expansion of the Uí Bhriain, the most aggressive of the east Thomond clans (Ó Corráin 1972: 7-9, 30, 31, 114, 121). For the Uí Lochlainn, whatever about the Uí Conchúir, there was the additional draining factor of internal dynastic disputes, which weakened the clan at crucial times over this extended period (see, for example, Frost 1893: 16). From the mid-fourteenth century, in fact, both Uí Conchúir and Ui Lochlainn clans had been obliged to pay tribute to the Ui Bhriain (Nugent 2007: 73). And as late as 1592 we find Iriall Ua Lochlainn signing a deed of submission to Donough O'Brien, fourth earl of Thomond (O'Donovan and O'Curry 1997).

Over the course of the sixteenth century, in fact, Uí Lochlainn decline had accelerated, and even though the Composition of Connacht of 1585, a taxation agreement between the English Crown and the western Gaelic lords, accorded specific recognition to them, the extent of the lands referred to in the agreement reveals more than anything else how much their patrimony had shrunk by that time (Freeman 1936: 14, 17, 21-2). One significant aspect of the Composition as it relates to the Uí Lochlainn was that it stipulated that after the death of the current dynast, all 'rents, duties and customs', 'as are challenged to belong to the name of O Loghlin shall … be thenceforth utterly extinguished and determined forever' (Freeman 1936: 27).

For the Uí Lochlainn, as for so many other clans, the debilitating effect of the Composition of Connacht on clan structure was compounded by their inability to adapt to the new market economy that gradually extended over Ireland as the English hold on the country strengthened, particularly in the period following the Treaty of Mellifont in 1603. In the new socio-economic dispensation that emerged following the Battle of Kinsale, the prized generosity of clan chieftains, as eulogised for centuries by Gaelic poets, now amounted to little more than a reckless spendthrift addiction, of which commercially minded newcomers were happy to take advantage. It is noticeable in this regard that during the early century much Uí Lochlainn land was being leased, mortgaged or sold to merchants from Galway City (see, for example, Frost 1893: 307-8 and Nugent 2007: 227-8).

By 1641, however, much land still lay in the hands of Ui Lochlainn clan members and freeholders. According to the *Book of Survey and Distribution*, that great cadastral compendium record of seventeenth century Ireland, Acres – Dangan Upper – was in the possession of the heirs of Owney More O'Loughlin, the recently deceased clan dynast, who shared the denomination with one William Nealan, of another lesser Gaelic clan, who were altogether more successful at adapting to the new socio-economic order. Owney More's son and principal heir, Owney Oge, who is recorded as owing a portion of the adjoining townland of Tonarussa in the *Book of Survey and Distribution*, was to be the last functional dynast of his ancient line (Simington 1967: 478).

As with so many clans throughout Ireland, indebtedness accounts for the prominent showing of the Ui Lochlainn/ O'Loughlins in the 1641 Rising, and thus we see Owney Oge, along with his three sons and their followers, riding south in December 1641 to raid for cattle at a farm near Kilnaboy, owned by a Englishman named Gregory Hickman, to whom clan members owed sums of money (Frost 1893: 342, 356). Owney Oge and his sons were later present at the siege of Ballyalia, near Ennis, the main event of the Rising in Clare (Frost 1893: 347). Having participated in the Rising, they lost their lands afterwards, and they disappear almost entirely from the record.

After the collapse of the Catholic Confederate regime that had ruled much of Ireland for nearly a decade, Parliamentarian forces entered Clare early in 1651, campaigning with exceptional barbarity. In North Clare, according to one near-contemporary account, troopers under the command of Sir Hardress Waller and Sir Henry Ingoldsby massacred more than a thousand 'poor labourers women and children' in Corcomroe and Inchiquin baronies, all of them officially under protection. In Burren barony the same troopers were reported to have killed some '800 men, women and children' (R. S. 1662: 21). To this level of mass human fatality can be added those killed during the prolonged counter-insurgency campaign carried out against Irish troops fighting a guerrilla resistance, as well as those who perished of epidemic diseases (Dunlop 1913: 46, 83, 207, 215; Frost 1893: 387-8).

How these dreadful events worked out locally in Drumcreehy parish, and in Dangan and Acres, is uncertain, but we do know that even further disruption was to be visited upon these districts, since Burren was one of the baronies where the Commonwealth regime began to apportion land to Catholics expelled from elsewhere in Ireland during the 1650s. The process of resettlement may well have begun in Drumcreehy before the scheme was abandoned, after it was realised that 'such places' were 'reputed and known to be sterile', and that to begin resettlement might hinder the transplantation project by discouraging others who came afterwards (Dunlop 1913: 531). Later on, the Commonwealth authorities ordered the resettlement of inhabitants of County Kerry into the locality, although we have little direct evidence that this scheme was proceeded with either (Dunlop 1913: 566-7). Neither do we have any clear idea how the transplantation was implemented, only that it was done amidst the greatest inefficiency.

We have just one indication as to the depopulation that resulted from the devastation wrought in Drumcreehy parish during the Commonwealth period; this is contained in a poll tax return from 1660. In the townlands of the parish that are recognisable to us in the return (others are unidentifiable, others clearly belonging to other parishes), we find just twelve persons living at Newtown, five at Muckinish (two amalgamated townlands East and West), fourteen at Ballyvaughan, fifteen at Ballyconry and seven at Ballycahill. Only at Newtown and Ballycahill were there 'tituladoes', that is, well-off taxable landholders, in residence. At Dangan (including Acres), there were only seven inhabitants, none of them identified personally (Pender 1939: 186). As far as it is possible to determine, the tituladoes mentioned in the poll tax as resident in the other denominations of Drumcreehy were in actual possession of the land at Acres and Dangan, but we are left uncertain as to which of them exactly owned what. The tituladoes, incidentally, and all the inhabitants of the parish are identified in the poll tax return as Irish, although the tituladoes' names are clearly indicative of transplanter origins and of lost lands elsewhere in Ireland.

We know very little else regarding the north Burren at this time, or of how its surviving population was affected under the Restoration regime after 1660. All we know is that by the late 1670s, after a new compromise land settlement had emerged in Ireland, Acres-Dangan was in the hands of one Edmond Nugent, a relative no doubt of the original titulado of 1660, the only other recorded landowners being one William Nealan, of the neighbouring Gaelic family that had formerly constituted a rival clan to the Uí Lochlainn (Simington 1967: 478).The power of the Uí Lochlainn was quite gone, although individual branches would still remain as landholders in other areas of north Clare.

Little further hard evidence can be adduced that would help us establish a historical background for the boy from Moneen Cave, and all that remains to be addressed are issues relating to the most likely period for his existence, and some inferences as to his possible identity. Probably the most likely timeframe lies during the upheavals of the Commonwealth period (1649-1660), when all Clare endured nearly two decades of famine, warfare, disease, and mass human casualty and displacement. As against that, however, it has to be said that there were other periods of disruption over the entire period under consideration that might easily accord with the known facts of his life experience. For that matter, it could be argued that all that would be needed to produce the effects of food deprivation, stunted growth and bodily stress that are revealed in the boy's bones might be a prolonged withholding of proper nutriment, enforced work and sustained brutalisation on the part of an employer or family members; this could as easily have happened at any date between 1520 and 1670, in times of peace and plenty just as in times of war and deprivation.

Can we then make any estimate as to the boy's status or occupation? Our best guess surely must relate to the sort of agriculture practised in the northern Burren in the early modern period as for generations before and afterwards (Nugent 2007: 228). Leaving aside a subsistence level of cereal production (mainly oats), this was a simple pastoral agriculture, in which a form of transhumance or 'booleying' predominated. Historically, as John Feehan (2004: 422, 425) has noted, booleying in the Burren has reversed the common pattern, in that instead of the more usual practice of herding cattle on upland slopes in summer and bringing them down in winter, they are brought to the upland pastures during the winter months, often from as early as October and left there until May the following year. The warmth of its limestone winterage is what has always made land in the Burren so valuable, and if there were any doubt as to the fertility of the Burren valleys and slopes in the early modern period, we have the contemporary evidence of no less an authority than the Cromwellian general Edmund Ludlow to the effect that cattle in the Burren were 'very fat', since 'the grass growing in turfs of earth, of two or three foot square, that lie between the rocks', was 'very sweet and nourishing' (Ó Dálaigh 1998: 38).

In all likelihood, therefore, the Moneen Cave skeleton represented a young herd boy, left in isolation to tend to his flocks or his herds, a *sclábhaí*, as the expressive Irish term has it, his short and harsh existence ending in a tragedy whose nature will never be known, and whose full poignancy therefore escapes us.

Part III
Discussion and interpretation: Moneen Cave in context

21. Hints of an Early Mesolithic and/or Neolithic presence

Two pieces of evidence recovered during excavations suggest Neolithic activities in the vicinity of Moneen Cave, though not necessarily inside the cave. The distal end of a broken flint flake (Figure 89) was recovered from C.3 in the descending artificial passage (Level 2) dug out by cavers. The same stratum contained Bronze Age pottery confirming this was a disturbed context. Indeed, the entire layer may have originated from the cave chamber overhead. The flake was examined by Peter Woodman (pers. comm.) who noted that it bears some recent damage on the right lateral edge, evidenced by differential patination. It is weathered and patinated white, and he attributed it to the Neolithic or earlier Mesolithic. The weathered nature of the flake suggests that it was exposed for some time aboveground before finding its way into the cave. It may even have been introduced at a much later stage, for example, at the same time as the antler fragment or Bronze Age pottery as all these similarly displayed signs of weathering.

The Mesolithic is not well represented in the Burren but the two recently excavated Late Mesolithic hunter-gatherer-fisher camps at Fanore More, one of which continued in use into the Early Neolithic, indicates that the area was populated. A range of activities were revealed at these coastal sites including the exploitation of marine resources (periwinkle, limpets, crab, fish), shale and chert knapping, and axe manufacture. Dates from the earlier site attest to activities between 4,965 and 4,815 cal BC (www.excavations.ie/report/2013/Clare/0022650/). Fanore More lies just over 12km west of Moneen Cave as the crow flies, or a relatively short boat ride around the coast from Ballyvaughan.

Neolithic activities in the Burren are represented by sites such as the Early Neolithic portal tomb at Poulnabrone 7.5km south of Moneen Cave (Lynch 2014); the Linkardstown-type burial cairn at Poulawack some 9.5km south of the cave (Hencken 1935); Parknabinna chambered tomb some 14km to the south (Jones 2004); and axe production sites along the Doolin coast 22km to the southwest (Jones 2004: 40). There is no clear evidence for the Neolithic use of caves in the Burren, though a hare bone from deep inside Glencurran Cave has returned a Neolithic radiocarbon date and, considering the focussed use of this part of the cave for ritual deposition in the Bronze Age, the hare may reflect human activities rather than a natural occurrence (Dowd forthcoming).

The juvenile bear femur from C.10 in one of the deepest parts of Moneen has been radiocarbon dated to 4373±38 BP, 3091-2907 cal BC (Figure 27), placing it in the Middle Neolithic. Bear bones of Neolithic date are relatively rare in Ireland and this is the first example of a Neolithic bear from the Burren. An adult bear scapula from Glencurran Cave has been radiocarbon dated to the Early Mesolithic, at 8999±31 BP (UBA-13246), 8287-8019 cal BC (Dowd forthcoming), while the bear remains from Aillwee Cave do not appear to have been radiocarbon dated. Elsewhere in Ireland, bear bones of Neolithic date have been recovered from two caves in County Leitrim, Poll na mBéar and Poll Ding Dong (Polldownin), with dates of 4520±37 BP and 4136±37 BP respectively (Edwards *et al*. 2011: fig. 3). None of these four sites – Glencurran, Aillwee, Poll na mBéar or Poll Ding Dong – have produced indications of human activities at the caves contemporaneous with the respective dates of the bear bones. The Moneen Cave bone may reflect a cub that died in the cave during hibernation, or an animal that was born in the cave but could not get out. The entrance is in the roof and while it would have been easy for animals to jump or fall in, it would not have been easy to climb out. The bear cub is represented only by one bone, and so other possibilities include an animal dying outside the cave with some elements dragged in by prey or naturally falling in. However, human activities cannot be entirely dismissed, not least because of the flint flake which may be contemporaneous. Though this is a tenuous link, future excavations at the cave may throw light on the nature

Figure 89 Distal end of a broken flint flake (11E0316:03:163) (Thorsten Kahlert).

FIGURE 90 FEMUR OF NEOLITHIC BEAR CUB, AGED UNDER 3 MONTHS AT THE TIME OF DEATH (THORSTEN KAHLERT).

of the bear remains and/or any potential association with Neolithic human activities.

In summary, the flint flake from Moneen Cave is limited in what it can tell us, particularly as its date is uncertain and it is an isolated find. However, as there are no known or recorded Mesolithic or Neolithic sites in this immediate vicinity (i.e. within a 2km radius), the find at least attests to the likelihood that early prehistoric people traversed Moneen Mountain or perhaps lived not too far away. The bone of a bear cub may, tentatively, be related to human activities but this is far from certain and may equally reflect a natural death, such as use of the cave as a hibernaculum.

22. An Early Bronze Age horizon: an antler hammerhead/ macehead and a pig pelvis

Two elements from Moneen Cave reveal an Early Bronze Age horizon: a pig pelvis and a perforated antler hammerhead/macehead. Both were recovered from Level 2 and had probably been displaced from the main cave chamber in antiquity. The pig bone came from C.1 while the hammerhead/macehead was found before the archaeological excavations but, from the cavers' recollections, it seems to have originated from roughly the same area and context as the pig pelvis. Though the two radiocarbon dates suggest separate events (Figure 91), potentially a century or two apart, they may indicate that Early Bronze Age use of the cave was focussed in the south-eastern part of the cave chamber around Rock A. Later activities may have caused these two early elements (and presumably other material) to have been pushed aside and downwards into Level 2. The similarity of find location and date also strongly suggests that the pig bone relates to human rather than animal activities. What an isolated pig pelvis (Figure 92) can reveal is limited, though some of the other unidentifiable middle-sized mammal bones may derive from the same animal (Section 8). Was a whole pig once deposited in the cave? Or portion of a pig? The pelvis may represent part of the buttock, thigh and upper leg – one of the main meat bearing portions of a pig carcass, and thus plausibly reflects a joint of ham. Or was this deposit simply a single bone? That the pig bone represents the debris of someone sheltering in the cave cannot be dismissed, but the absence of other occupation debris of Early Bronze Age date makes this hypothesis unlikely. An argument will be made in what follows that the majority of the Bronze Age material from Moneen Cave represents ritual activities and

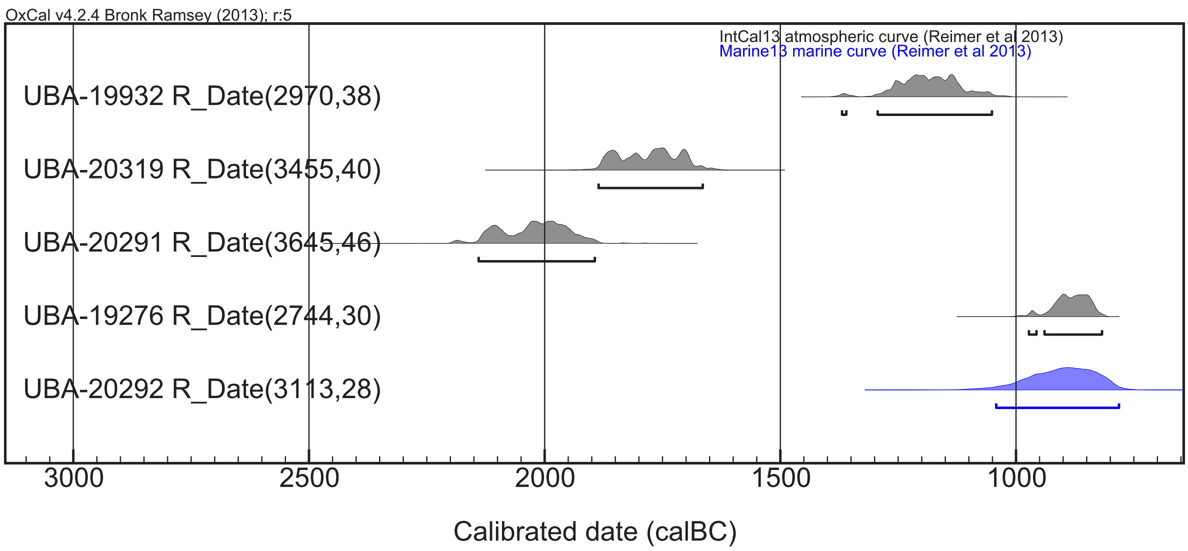

FIGURE 91 PLOT OF BRONZE AGE DATES FROM MONEEN CAVE.

Figure 92 Early Bronze Age pig pelvis (Marion Dowd).

Figure 93 Early Bronze Age antler hammerhead/macehead (11E0316:0X:252) (Thorsten Kahlert).

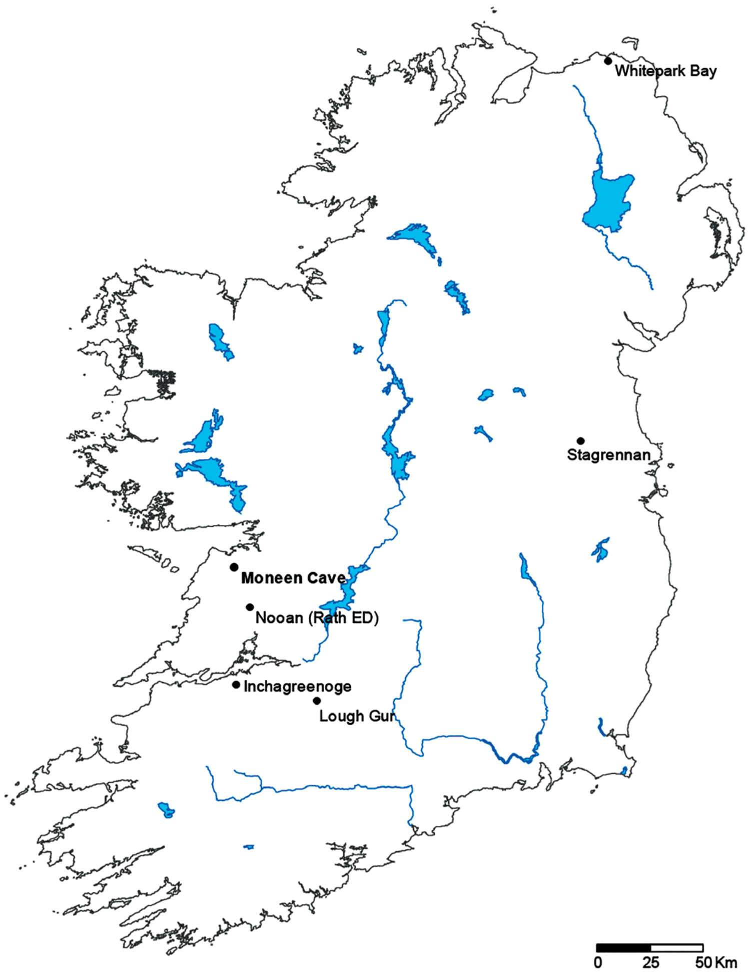

Figure 94 Distribution of perforated antler hammerheads/maceheads from Ireland (Thorsten Kahlert).

votive deposits. The pig pelvis may well form part of such practises.

The perforated antler hammerhead/macehead is relatively unique in an Irish context and has been dated to the Early Bronze Age: 3645±46 BP, 2139-1895 cal BC (Figure 93). Calcite on one surface indicates it lay exposed in the cave for some time and was not buried or concealed. The burr was intact and there was no sign of a pedicle indicating that the antler had been shed naturally and had not been removed from a dead stag. The opposite end was polished. The part that was used included the burr, lower part of the beam, and parts of the brow and bez tines. The perforation indicated that the antler piece was hafted, presumably with a wooden handle.

A variety of perforated antler implements are known from across Bronze Age Europe including mattocks, hammerheads, sleeves for axeheads, and ceremonial maceheads. Perforated antler artefacts are quite rare in prehistoric Ireland, however, which is emphasised by the confusion as to whether the Moneen object should be referred to as a *macehead* or a *hammerhead*. *Hammerhead* implies a functional utilitarian tool. The end that would conceivably have been the point of contact with another surface, the hammer, shows no traces of damage. A hairline

County	**Townland**	**Context**	**Reg. no.**	**Max. dimensions (mm)**	**Reference**
+Antrim	Whitepark	Settlement: Coastal	Unknown	Length: *c.* 190 Width: *c.* 50 Perforation: *c.* 38x32	Knowles 1885, 119, plate IX, no. 90
Clare	Acres	Cave: Moneen	11E0316:00:252	Length: 157 Width: 66 Perforation: 34x28	Dowd 2013a, 2013b
*Clare	Nooan (Rath ED)	Lake: Lough Inchiquin	1940:24	Length: 147 Width: 69 Perforation: 27x25	Liversage 1957 Raftery 1941
*Limerick	Inchagreenoge	Bog	02E0899:59	Length: 175 Width: 80 Perforation: 25x22	Taylor 2004
+Limerick	Lough Gur	Settlement: Site D	Unknown	Length: *c.* 124 Width: *c.* 100 Perforation: *c.* 40x30	Ó Ríordáin 1954, 409-10, figure 42, no. 9
Meath	Stagrennan	River: Boyne	99E0535:60	Length: 132 Width: 73 Perforation: 35x25	Whitaker 2003

*Examined by M.D. in the NMI in July 2013.
+These artefacts could not be located in the NMI in July 2013.

Figure 95 Details of perforated antler hammerheads/maceheads from Ireland.

crack extends longitudinally along the narrow upper and lower surfaces of the object (Figure 93). This may have been a result of impact if the artefact had been used as a hammer to strike with considerable force. There is no crushing or pecking on the polished end or on the burr, which might be expected if the object was used as a percussive tool. *Macehead* implies a ceremonial or prestige item that played a role in ritual activities and was manufactured with a specific function and meaning in mind. Of course, these categories of utilitarian tool and ritual implement are not mutually exclusive. Even if the Moneen object originally served as a utilitarian hammer, it is likely to have been a significant object considering the importance of deer in prehistoric Ireland and their relative rarity in Neolithic and Early Bronze Age landscapes (Carden *et al*. 2012).

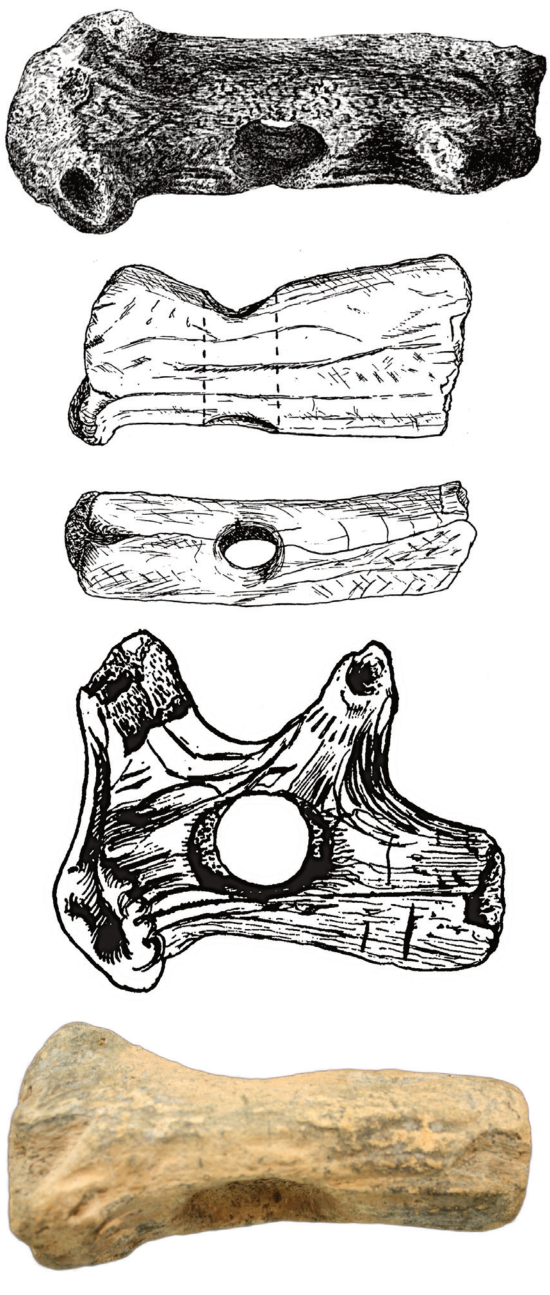

Figure 96 Perforated antler hammerheads/maceheads from Whitepark, Antrim (Knowles 1885: pl. IX); Nooan, Clare (Liversage 1957: 170); Loughgur, Limerick (Ó Ríordáin 1954: 410); and Stagrennan, Meath (ADS Ltd.). Not to scale.

The Moneen object is broadly similar to Neolithic maceheads found in Britain (Loveday *et al*. 2007; Simpson 1996), but also displays significant differences. In the region of 60 antler 'crown' maceheads are known from Late Neolithic Britain, approximately 75% of which derive from the River Thames and its tributaries (Simpson 1996: 293-5, 299). These could reasonably be argued to represent votive deposits, not least because the remaining maceheads largely occur in funerary contexts, primarily accompanying high status adult male burials in northern Britain; only one is recorded from a settlement site (Loveday *et al*. 2007; Simpson 1996: 296-7). Simpson (1996: 299) has argued, based on their archaeological contexts, that the British Neolithic antler maceheads are 'clearly high status objects'. A significant difference between the British examples and the artefact from Moneen Cave is that the latter is at least 60mm longer (when compared with data in Simpson 1996). Further, a small number of British examples have carved decoration whereas the Moneen example is undecorated. Finally, though most of the British maceheads have not been radiocarbon dated, seven dated examples from across Britain have returned largely Middle Neolithic dates (Loveday *et al*. 2007: 387), whereas the Moneen item is approximately a millennium later and reflects an Early Bronze Age horizon.

Perforated antler implements from Ireland

Five perforated antler objects from elsewhere in Ireland can be broadly compared to the object from Moneen Cave. Though none of these have been radiocarbon dated, associated finds tentatively suggest that all date to the Bronze Age or Neolithic (Figures 94-96).

The earliest recorded object from this group was an antler 'horn hammer' recovered by antiquarian William J. Knowles in 1885 during investigations of sand dune sites at Whitepark Bay near Ballintoy on the north Antrim coast (Knowles 1885: 119). The precise context of the find is unclear but it appears to have derived, along with hundreds of prehistoric artefacts, from habitation strata associated with a series of circular huts. He found it 'when digging over a piece of the old surface' (Knowles 1885: 119). Other finds from these 'Sandhills' sites included flint artefacts (convex scrapers, blades, flakes, debitage, arrowheads), hammerstones, sherds of Bronze Age vessels, bone points and needles, and worked bone and antler. Knowles' assemblage from Whitepark Bay comprised material predominately of Middle and Late Bronze Age date (Woodman *et al*. 2006: 251). While much of the Bronze Age material suggests occupation debris, the presence of clay mould fragments, including fragments of moulds for Late Bronze Age leaf-shaped swords (Woodman *et al*. 2006: 251), suggests high status occupation and/or a metalworking site. In the absence of radiocarbon dating, a Bronze Age date would seem likely for the perforated antler object.

Four of the six known perforated antler objects come from Munster, with two from Clare and two from Limerick (Figure 94). The Lough Inchiquin example was found approximately 17km south of Moneen Cave, the Inchagreenoge site lies about 60km south of the cave, while Lough Gur is 75km southeast of Moneen Mountain. It is plausible that this represents a regional phenomenon in the manufacture and use of perforated antler hammerheads/maceheads, a hypothesis that can only be corroborated or refuted by future discoveries.

The perforated antler object from Lough Inchiquin was found in 1939 on 'the bed of Inchiquin lake when the water was unusually low' (Topographical Files, NMI). It was tentatively identified as made from the antler of a giant deer (Liversage 1957: 169), but this is questionable, not least because of weathering on the surface of the object, though modern reanalysis should be able to clarify the issue. If it is, however, from a giant deer then the object may be Upper Palaeolithic, or it may have been fashioned during the Neolithic or Bronze Age from an already ancient antler. Both ends of the object were cut, removing most of the burr from one end and exposing the spongy interior at both ends. It was described as 'blunt at both ends, so it may have been either a hammer or a mace' (Liversage 1957: 170). The NMI registers indicate that since the 1930s at least 20 stone axes, boar tusks and a Bronze Age sword have been found on the edges of Lough Inchiquin at low water (Topographical Files, NMI). Most if not all of these finds suggest votive deposition of material into the lake.

The perforated antler object from Inchagreenoge, Co. Limerick was discovered during excavations in 2002 (Taylor 2004). It came from a multi-period site (44m x 19m) in wet peaty ground where two fulachtaí fia, deposits of burnt stone, a human skull deposited on the edge of a natural spring, a wooden platform or trackway, wooden artefacts, animal bones and a post-medieval stone trackway were recorded. Prehistoric artefacts recovered included a sherd of prehistoric pottery, flint flakes and scrapers. While radiocarbon dates are necessary, and the chronological relationships between artefacts and structures at Inchagreenoge are unclear, there is a strong likelihood that the perforated antler object is Bronze Age in date.

A perforated piece of antler was also recovered from Site D at Lough Gur, Co. Limerick, which comprised one stone and two wooden houses, terracing and two burials. One of the finds from excavations here in the 1940s and 1950s was a perforated piece of antler from an unspecified context (Ó Ríordáin 1954: 409-10, fig. 42, no. 9). It consists of part of the main shaft and differs in appearance from the other objects under discussion here in that the lower portions of the bez and brow tines have not been removed. Most of the occupation phase and the burials at Site D have been dated to the Middle Neolithic, but Beaker and Bronze Age activities are also represented (Smyth 2014: chapter 5). The perforated object could, therefore, date to the Neolithic or Bronze Age.

An undated perforated antler object was recovered at Stagrennan on the Boyne River, Co. Meath, during dredging operations in 1999 (Whitaker 2000: 245). It is a relatively crude implement and the burr has been removed. Other *ex situ* material retrieved included over 3,600 pieces of worked flint, 19 human bones of unknown date representing at least six individuals, and a Late Bronze Age basal looped spearhead (Whitaker 2000: 244-5, 2003). An Early Bronze Age flat bronze axe (1968:297) is also on record from the Boyne River at Drogheda.

A few general observations can be made about the six Irish perforated antler artefacts:

Red deer At least five are made from antlers of red deer. It was suggested in the 1950s that the Lough Inchiquin example had been made from a giant deer antler, but this assertion remains dubious. Five artefacts (Whitepark, Lough Inchiquin, Inchagreenoge, Lough Gur, Moneen) retain portions of the burr and, of these, three (Lough Gur, Moneen, Inchagreenoge) and possibly four (Whitepark) retain the entire burr. The presence of the burr indicates secondary exploitation, in that the objects were made from naturally shed antlers that were likely collected from the landscape or represent traded materials.

Morphology All six artefacts comprise the lower part of the beam. Apart from the Lough Gur object, the bez and brow tines have been removed in all instances though traces of these elements are still visible. Perforations in all cases are oval rather than circular and occur roughly midway along the length of the piece. All six are undecorated. Most of the objects appear to be weathered which may reflect the natural and active contexts in which they were found. The Moneen find, however, does not exhibit weathering.

Function The broad similarity between the six objects suggests they served a similar purpose. Beyond that, however, no clear function can be established. The perforation indicates hafting, if these are considered utilitarian tools such as hammerheads. None of these six reflect the morphology of an antler sleeve (e.g. for a stone axehead), and there is no working to suggest they acted as picks, axeheads or adzeheads in themselves. The absence of damage or battering on the 'working ends' suggests these were not used as percussive tools or hammers, even if originally hafted with that intention. The perforations do, however, suggest these objects were mounted, if they are to be considered maceheads. That said, none of the objects are decorated or carefully carved or polished, which might be expected if they were prestige or ceremonial items.

Date Only one example (Moneen) has been directly dated, returning an Early Bronze Age determination. The Whitepark and Inchagreenoge examples come from sites that represent primarily Bronze Age activities. Based on other finds from the following sites (though not directly associated), the Lough Inchiquin, Lough Gur and Stagrennan objects could be Neolithic or Bronze Age.

Context None of these artefacts come from secure contexts. Two examples may come from settlements (Whitepark, Lough Gur); three come from 'watery' or 'wet' places' in the landscape (Lough Inchiquin, Inchagreenoge, Stagrennan); one comes from a cave (Moneen).

Natural places in the landscape There is a marked correlation between these objects and natural places in the landscape. One is from a lake (Lough Inchiquin); one is from a river (Stagrennan); one is from what was probably a bog (Inchagreenoge); and one is from a cave (Moneen). All these locations are typical of the types of places in the landscape that became foci for votive deposition in the Bronze Age (Bradley 1990, 2000). Even the two examples from settlement sites highlight natural places in the landscape: the Whitepark example is from the coast and the Lough Gur artefact is from a rocky area on Knockadoon Hill near the lake. It could also be tentatively suggested that there may be a regional bias in the location of this artefact type: four of the six examples come from north Munster (Figure 94).

Ritual deposition The occurrence of these objects at natural locations strongly suggests that most, if not all, did not function as utilitarian objects, at least not at the end of their lives. The abundance of polished stone axes at Lough Inchiquin is a strong indicator of Neolithic and/or earlier Bronze Age votive deposition at this lake, and the antler object plausibly reflects the same practise. The Middle Bronze Age and Late Bronze Age material from Moneen Cave similarly suggests votive deposition (Section 23). Votive deposition in rivers is a recognised phenomenon of the Irish Bronze Age (Bourke 2001) and the Stagrennan example may well be part of that phenomenon, not least considering the discovery of a Late Bronze Age spearhead during the same dredging operations in which the antler object was recovered. At Inchagreenoge, the recovery of a human skull from a natural spring again speaks of ritual activities, and the fulachtaí fia may have served a ritual function for a time also. The antler object may therefore be linked to ritual activities or deposition in this boggy part of the landscape. While Whitepark and Lough Gur reflect Bronze Age and/or Neolithic settlements, an interesting aspect is that clay mould fragments were found at both sites suggesting that during the Late Bronze Age these settlements may have been of 'non-ordinary' or special status.

In summary, the perforated antler hammerhead or macehead from Moneen Cave raises more questions about the artefact type generally, and the cave specifically, than it answers. It serves to raise awareness of the need for further study into this artefact type, and particularly the direct dating of the other examples. In my opinion, the Moneen artefact is likely to represent a special votive deposit at a special place in the landscape, notably because of the subsequent seeming ritual deposits in this cave, as well as the absence of other Early Bronze Age material from the site (e.g. occupation debris). Furthermore, antler appears to have been largely restricted to the manufacture of artefacts associated with burial and ritual contexts in Neolithic and Bronze Age Ireland, suggesting the Moneen artefact was more than a simple household tool – though this possibility cannot be altogether discounted.

Looking more broadly at the evidence for Early Bronze Age activities in the Burren, settlement and domestic activities are not as well represented as sites related to the funerary and ritual aspects of life, but there is growing evidence of thriving communities living in the wider environs of Moneen Cave. Early Bronze Age settlement sites include a rectangular house constructed within a doline at Caherconnell some 8.5km south-southwest of Moneen (Hull 2011); a network of field systems and settlement at Roughan Hill 13km to the southwest (Jones 2015); and domestic occupation in a doline at Teeskagh 11.5km from Moneen Cave (Gibson 2016).

A number of monuments in the Burren reflect an Early Bronze Age concern with older sacred places in the landscape, lending further support to the tentative suggestion that Moneen Cave may also have been a recognised and significant location for Neolithic people. Sherds of Beaker pottery and a small collection of lithics from the chamber of Poulnabrone portal tomb arguably comprise ritual offerings deposited at the very beginning of the Bronze Age (Chalcolithic). Somewhat later, a human foetus accompanied by sherds of pottery was interred deep within a grike at the portico of the tomb (Lynch 2014: 189). The evidence for structural modifications to this Neolithic monument during the Early Bronze Age (Lynch 2014: 189) is also relevant to Moneen Cave. The only apparent structural modification to the cave was the creation of the wall niche. The date when this was quarried out is not known – it may be a post-medieval feature – but on balance of evidence it seems more likely that it was created at some point during the Bronze Age. A potential Bronze Age date for the niche ties in with broader patterns. In prehistoric Ireland it is only during the Bronze Age that we find marked evidence for the modification of interiors, the construction of structures, and the management of space within caves (Dowd 2015: chapter 6). The niche at Moneen is located close to Rock A, which dominates the chamber, and the niche may have functioned in relation to this focal feature, perhaps as a place to display artefacts and materials. The Neolithic burial mound at Poulawack (9.5km from Moneen Cave) was also enlarged and modified during the Bronze Age, and a series of cremated and inhumation cists burials were inserted into the monument during the Early and Middle Bronze Age (Hencken 1935).

23. Middle and Late Bronze Age deposits

The most distinct phase of prehistoric activity at Moneen Cave dates to the end of the Middle Bronze Age and the beginning of the Late Bronze Age, *circa* 1000 BC. Over 350 pottery sherds representing six vessels can be assigned to this period. The radiocarbon dates also reflect a spike in activities at this time: an unmodified fragment of a red deer antler, an oyster shell and a butchered rib bone from a large mammal all returned dates from the Middle and Late Bronze Age (Figure 91). The spread of dates suggests repeat rather than single events, and speaks of intentional visits to the cave during the Bronze Age, but apparently not during the Neolithic, Iron Age or early historic periods.

At first glance the Middle and Late Bronze Age assemblage – an antler fragment, oyster shell, pottery, and butchered animal bones – might appear to represent occupation debris. The spread of dates, however, suggests at least two separate events. Further, while pottery and butchered animal bones occur on Bronze Age settlement sites, unmodified pieces of red deer antler and oyster shells would be considered quite atypical finds. In addition, the quantity of pottery from Moneen Cave – 353 sherds – is disproportionately high compared to contemporaneous settlement sites. For instance, approximately 200 sherds were recovered from a settlement enclosure at Ballyveelish, Co. Tipperary, while 166 sherds came from the Bronze Age settlement at Carrigillihy, Co. Cork (Waddell 2010: 207, 210). This difference cannot be solely attributed to the protective nature of caves which favours preservation of artefacts. If this cave had been inhabited, one might expect more structural evidence or modifications of the space, and a greater range of debris such as charcoal, lithics, bone implements, saddle querns and other artefacts. It is also difficult to envisage the cave as the dumping place of a nearby occupation site considering its upland and relatively remote location. If the cave had served simply as a place for waste disposal, one might expect a greater range of material as well as a greater fragmentation of the pottery directly under the entrance (where none was recovered). In contrast, the Middle and Late Bronze Age material occurred in the eastern part of the cave indicating that people entered the chamber and deliberately chose where to leave material.

The antler fragment is unmodified and does not show signs of human modification or cutmarks (Figure 97). Nonetheless, it is highly unlikely to be a natural occurrence in the cave, not least because of the absence of other identifiable red deer remains, the presence of the Early Bronze Age hammerhead/macehead, and the rarity of red deer on Bronze Age habitation sites. As has been mentioned earlier, there is also a striking correlation between antler artefacts and funerary and ritual activities in the Neolithic and Bronze Age (Carden *et al*. 2012; Morris 2005; Woodman and McCarthy 2003). This again suggests the unmodified antler fragment from Moneen Cave reflects a humanly made deposit, one that was ritually charged.

Four butchered mammal ribs (Figure 29) from the cave seem to represent joints of meat or portions of animal carcasses, and a certain number of the other animal bones probably derive from the same joints/animal portions. Zooarchaeological analysis identified these four as deriving from medium and large mammals, and additional ZooMS analysis made it possible to refine one of those determinations – one undated butchered rib was cattle and may reflect a beef cut. The Late Bronze Age butchered rib could be from cattle, sheep or deer (Section 9). That these butchered bones (and we cannot assume all are contemporaneous) represent the debris from short-term shelter in the cave cannot be dismissed, but taken in context with the other finds, this seems unlikely. Instead, we may be looking at the intentional deposition of joints of meat in the cave. Shellfish are also noticeably absent from Bronze Age settlement sites where evidence for the exploitation of wild resources is rare. While the coastline and the nearest likely source of the Moneen Cave oysters lies just 2.4km to the northwest, in an subsistence context it makes little sense to travel up a mountain to eat oysters. In fact, only right (upper) valves were found at Moneen (Figure 37) suggesting that isolated shells without the meat were brought to the cave. Clearly these oyster shells were symbolically meaningful to those who collected them from the shoreline, brought them up the mountain, and placed them in the cave.

Pottery was the most prevalent archaeological find from Moneen Cave. Sherds of Middle/Late Bronze Age vessels were recovered from almost 60% of contexts recorded during the excavation (see Appendix 1), but with two main concentrations. Spatial patterning suggested all the pottery had originally been deposited on or around Rock A, in the eastern side of the chamber, with the largest sherds coming from between the eastern cave wall and Rock A, and on the ground around the rock. This distribution could be explained if sherds or complete pots had originally been placed on top of this prominent boulder. Sherds recovered from Level 2 probably represent material that had worked its way downwards from the vicinity of Rock A via natural processes in antiquity and more recent caver activities. The six vessels represented in the Moneen Cave assemblage derive from bucket- or tub- shaped pots of types that characterised the later part of the Bronze Age (Figure 42). Despite the significant quantity of sherds present, nothing resembling a complete pot was recovered, though the partial nature of the excavation undoubtedly contributes to this factor. Vessel 6 was the best represented, yet only *c*. 20% of the original pot was recovered. Vessels 3, 4 and 5 were each represented by a very small number of sherds. The present evidence suggests that clusters of sherds but not complete vessels were deposited in the cave (Figure 98). Sherds were not casually thrown or dumped into the cave from the entrance, however, as they occurred predominately at the eastern side of the cave. This indicates that people had entered the cave chamber carrying bags, pouches or handfuls of sherds, then carefully placed these on or near Rock A. Whether the pottery assemblage represents a single isolated act of deposition, or multiple visitations and depositions, is at present not possible to establish.

Figure 97 Middle Bronze Age weathered but unworked antler fragment (Thorsten Kahlert).

Several of the pottery sherds displayed weathering (particularly from vessel 6), as did the fragment of deer antler and one of the butchered animal ribs. This level of weathering could not have occurred within the cave as it is an enclosed and protected space. The weathering on the lower portion of vessel 6 suggests the possibility that it was, at some point in its life history, inverted. If it had been inverted and partially buried in the ground outside the cave, for instance, the upper portion would have been protected leaving the lower part exposed to weathering. The inversion of vessels in Bronze Age burial and ritual is a particularly common phenomenon across Ireland

Figure 98 Middle/Late Bronze Age pottery sherds from Moneen Cave (Thorsten Kahlert).

and Britain (Waddell 2014: 74), lending further credence to the argument that the pottery from Moneen Cave was non-domestic in nature – at least latterly in its role as material for deposition in the cave. Waddell (2014: 74-9) has suggested that inversion and reversal, as reflected in Bronze Age burial pottery as well as elsewhere in the prehistoric world, is a reference to the Otherworld and the dead. If such ideas existed around the Bronze Age use of Moneen Cave, this dark underground space may also have been perceived as a physical inversion of the bright aboveground world.

The weathering on some of the pottery sherds, the antler fragment and one of the animal bones suggests that material which had been exposed to the elements for some time outside the cave was collected up and brought to the site. What this represents is unclear. Does exposure to the elements imply this was refuse lying about in a domestic context? Or could some material have been brought from another ritual or funerary site where it had been open to view for some time? A similar scenario is suggested when the material entered the cave. The hammerhead/macehead and some of the pottery had a thin wash of calcite on one surface indicating that some if not all of the material lay exposed within the cave but not buried within the sediment or under rubble. In this respect it is tempting to imagine deposits being placed on the flat narrow surface of Rock A where they rested for years, perhaps even centuries, before falling to the ground around the rock, or being pushed off the rock to make space for fresh deposits.

24. Moneen Cave within the wider Bronze Age landscape of the Burren

The 2011 excavations revealed that Moneen Cave was a focus for intermittent activities spanning the Early Bronze Age, Middle Bronze Age and Late Bronze Age. A range of diverse artefacts and materials were deposited in the cave over a period of approximately 1,200 years. While we cannot be sure that all these depositions reflect similar practises, the sporadic nature of the finds, coupled with the relative inaccessibility of the cave, and the non-occupation nature of the material, all suggest that visits to the cave served a non-utilitarian purpose. Three aspects of this small cave are arguably key to understanding why it held special significance for those Bronze Age people who visited it. Firstly, on cold dry days a plume of steam can be seen from a distance issuing from the cave and is visible from the foot of the mountain (Denise Casserly pers. comm.). This natural phenomenon likely alerted people to the presence of the cave, and the plume may have been interpreted as a sign the cave was 'breathing' and thus an animated place (Dowd 2016: 68). Secondly, the cave entrance is very small and quite concealed, with no evidence of attempts to enlarge it and make the cave more accessible or more habitable. It is largely a hidden site. Cavers, for instance, only heard of the cave in 2011 even though the Burren is the best-known and best-studied caving region in Ireland. Its relatively secret location may have been significant in how Moneen Cave was perceived. Thirdly, this is the only known cave in this part of the north Burren. Furthermore, Bronze Age activities are scarce in this upland region of the north Burren (Jones 2004: 59) with the majority of settlement and burial sites located in the southeast part of the Burren.

My interpretation of the Bronze Age material from Moneen Cave is that it represents repeat votive deposition at the cave, on an irregular and episodic basis over a long period of time. There is plentiful evidence for votive deposition at natural locations in the Burren landscape throughout the Bronze Age including an Early Bronze Age dagger from a sandpit in Gortaclare; an Early Bronze Age copper axe and a Middle Bronze Age leaf-shaped sword from near Lough Inchiquin (significant in terms of the perforated antler hammerhead/macehead also from this lake); a Middle Bronze Age rapier from a bog at Ballyconnor South; the Late Bronze Age metalwork from a boggy area at Boultiaghdine near Lough Inchiquin; and the famous Late Bronze Age gold gorget from a rock fissure at Gleninsheen (Jones 2004: 71-8). Perhaps because prehistoric metalwork was recognised as distinctive and 'precious', it has dominated discussions of votive deposition in late prehistoric Ireland. However, excavations at Glencurran Cave, some 12km south of Moneen Cave, revealed a complex and lengthy history of votive deposition during the Middle and Late Bronze Age. As with Moneen Cave, the Glencurran assemblage did not include metalwork, but rather more 'ordinary' deposits: sherds of Late Bronze Age pottery (representing four vessels); joints of meat (beef, mutton, pork); seemingly complete newborn domesticates (lambs, calves, piglets); and amber, stone and shell beads. Scattered amongst these deposits were disarticulated human bones with a preponderance of clavicles, and the remains of a burial of a 2-3 year old child (Dowd 2007, 2009). It is quite probable that votive deposition of more mundane material rather than prestige metalwork was far more common in Bronze Age Ireland but has not been recognised as such by archaeologists. For instance, the most common Bronze Age material from Irish caves comprises sherds of Late Bronze Age pottery, crude bucket- and tub-shaped vessels. Sherds representing 40 vessels have been documented from seven different caves. The most common pattern is the occurrence of small numbers of sherds that derive from several vessels. These sherds seem to represent token deposits rather than domestic occupation (Dowd 2015: 135). At Kilgreany Cave, Co. Waterford, for instance, a Late Bronze Age bronze razor, bronze knife, two bronze bulb-headed pins and sherds from 13 different vessels were recovered scattered through different strata in the cave (Dowd 2015: 134). Ten of the vessels were represented by eight or less sherds each, and were apparently deposited in the cave in a fragmentary state. In contrast, one vessel was represented by over 70 sherds and probably reflects the deposition of a complete intact pot (Roche 2016).

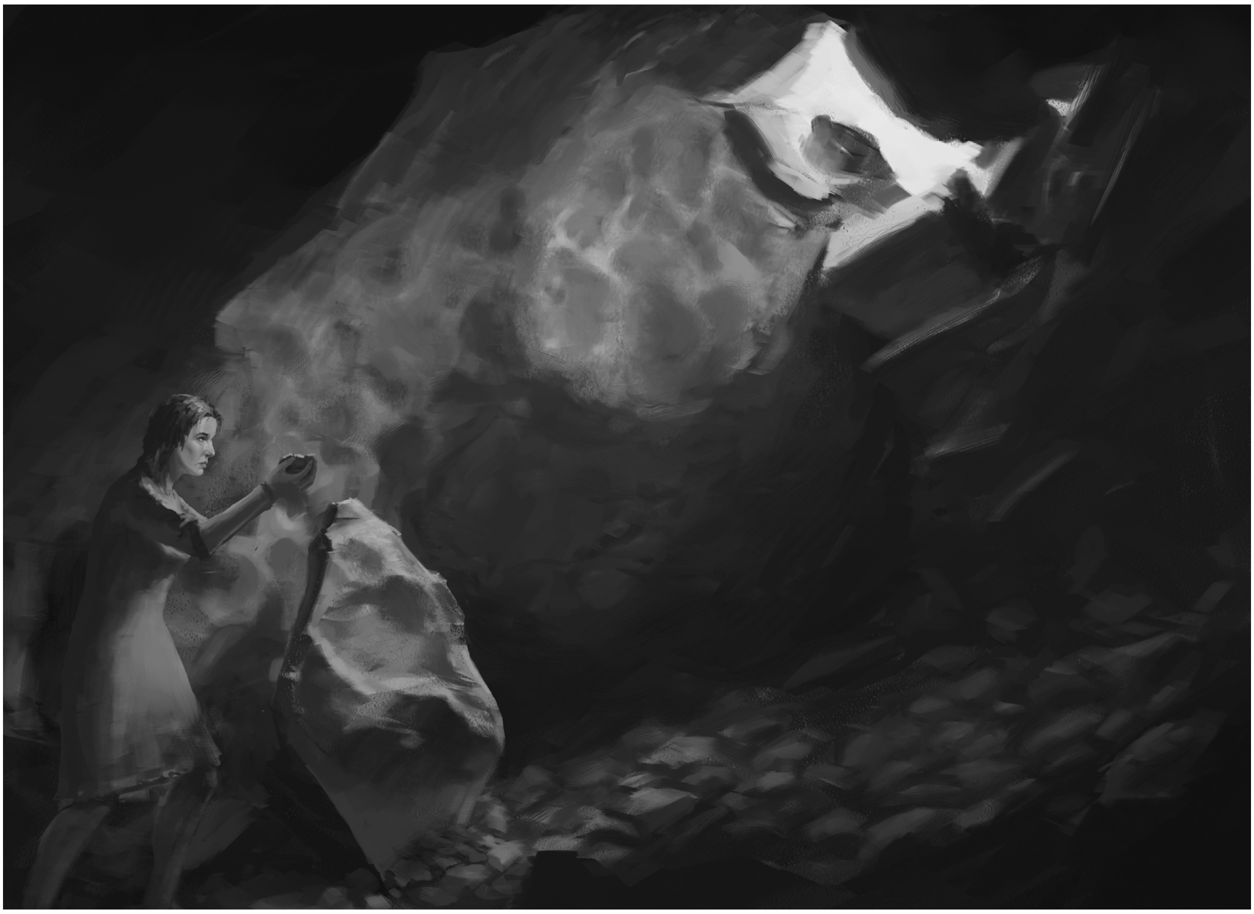

Figure 99 Reconstruction of Bronze Age activities at Moneen Cave (J. G. O'Donoghue).

It has been argued elsewhere (Dowd 2016) that Moneen Cave was one of a series of caves in Bronze Age Ireland that became foci of votive deposition, and potentially also ritual retreat. Rituals at these caves seem to play on dichotomies of public versus private; light versus darkness; the known and the unknown. I have suggested (Dowd 2015: 146-7, 2016: 68-9) that journeys to these cave entrances were public events, or were at least witnessed by the wider community, but that entry into a particular cave was reserved for one or a small number of individuals. The period of time spent inside in the darkness may have been monitored by those waiting outside, and events in the outside world (changes in the weather, in the health of an individual etc.) may have been linked to what was happening inside in the darkness. The longer an individual was isolated in a cave like Moneen, the stronger the emotional response of those waiting outside may have been. These may have been perceived as journeys into other realms, journeys into places where it was possible to communicate with the spirit world or the dead, or sojourns into subterranean spaces where wisdom or insight awaited. Some of the material culture found in Moneen Cave may reflect food consumed (butchered mammal bones) during a ritual sojourn in this space, and other material (pottery) may reflect offerings or objects employed in the rituals that took place therein. It is also possible that the artificial niche in the north wall of the cave was created by Bronze Age people, being later re-used in post-medieval times.

To date, there is little trace of Bronze Age communities in the immediate vicinity of Moneen Mountain, though the wider Burren landscape exhibits plenty such evidence as mentioned above. The sites closest to the cave are two fulachtaí fia (CL002-062----; CL005-059----) located 500m to the west-northwest and 600m to the west-southwest respectively, though in the lowlands (Figure 105). While radiocarbon dates from fulachtaí fia indicate their construction and usage spanning prehistoric and early historic times, the overwhelming majority date to the Bronze Age (Hawkes 2014, 2015; Ó Néill 2003/4). The people who utilised these two fulachtaí fia may have been aware of the cave, or may even have taken part in rituals associated with this site. Moneen Cave is located close to a low-lying valley pass between Moneen Mountain and Aillwee Mountain, which is likely to have been strategic both in prehistoric and historic times in term of access and travel. Two undated enclosures (CL005-209----; CL005-193----), potentially late prehistoric, located within this valley may have exercised control on movement through this mountain pass. It is noteworthy that apart from Moneen Cave, no archaeological sites have been recorded on the upland landscape of Moneen Mountain. In contrast, several sites are known on the adjacent Aillwee Mountain to the south, including a prehistoric cairn (CL005-060001-) and two undated enclosures (CL005-060002-; CL005-061----) (see Figure 105). Less than 2.5km south of Moneen Cave is Maze Hole on Aillwee Mountain (Mullan 2003: 179). Seashells are visible in the cave sediment here suggesting that this is also a cave of archaeological significance, but further investigations and radiocarbon dating are necessary to ascertain the nature and date of activities.

It is also worth noting that only three caves have been archaeologically excavated in the Burren – Robber's Den, Glencurran Cave, and Moneen Cave – and all three have produced evidence of Bronze Age activities, specifically of a ritual and/or funerary nature. The skeletal remains of an adult female of Late Bronze Age/Early Iron Age date were recovered from deep inside Robber's Den and appear to represent a burial (Dowd 2015: 143). There is little commonality between these three caves; they differ in terms of size, morphology, location in the landscape and the types of archaeological material deposited. That said, Robber's Den and Moneen are relatively difficult to access, and the same may have applied to the deeper parts of Glencurran Cave where Bronze Age material occurred. It is plausible that in the Burren, where caves are particularly abundant, the subterranean may have taken on an especially significant role in Bronze Age perceptions of life, death and the otherworld. Caves may have been generally associated with the ritual, funerary and religious aspects of life. Certainly there is no evidence of Bronze Age secular occupation of Burren caves, though this may simply be due to the restricted number of investigated sites. What is now necessary, but beyond the scope of this book, is a closer analysis of the relationship between what was happening underground and what was happening overground in the Burren during the Bronze Age.

At the time of excavations in 2011, it was apparent that at some point in the past efforts had been made to neatly block, or reduce the size of, the cave entrance. This attempt may have taken place in the later Bronze Age, perhaps to 'close' this ritual space. For example, at Glencurran Cave a large drystone structure was constructed and filled with a series of white clays at the end of the Bronze Age. This may have been one of the final, if not the final, ritual activities at Glencurran. Though it was constructed well inside the entrance, it seems to mark an internal transition point in the cave and the 'beginning' of sacred space as one enters, or the 'end' of sacred space as one leaves (Dowd 2009). It is possible, therefore, that blocking the entrance at Moneen Cave, and constructing a large drystone structure at Glencurran Cave, served to mark the final usage of both sites; these were effectively closing deposits. That said, it is not impossible that the entrance of Moneen Cave was partially blocked in post-medieval times by the adolescent who used the cave, or in even later centuries to protect livestock from falling in.

The multiple analyses conducted on the skeletal remains provide a very poignant insight into the life of this unfortunate boy. A number of observations can be made that have been extracted from the specialist studies in Part II:

- This adolescent male died most probably between 1520 and 1670, essentially the end of the high medieval period (1550) and into the post-medieval period.
- From a historical perspective, the most likely timeframe is during the Commonwealth period (1649-1660), when Clare endured nearly two decades of famine, warfare, disease, and mass human casualty and displacement.
- He was 14-16 years old when he died.
- He was almost certainly local to the area, and probably lived his entire life in the Burren. Irish

25. A post-medieval boy

Following the Late Bronze Age, Moneen Cave appears to have been largely forgotten about and there is no evidence to indicate it was visited or used during the Iron Age, early medieval period or high medieval period. The discovery of the skeletal remains of an adolescent boy who died in the 16th or 17th century is the only indication that the cave was known about or used in historic centuries (Figures 100-102). As with the Bronze Age, the cave entrance would have been relatively concealed measuring just 0.35m x 0.3m (Figure 4) and may only have been known to those farming that particular part of the mountain, or may have been accidentally discovered.

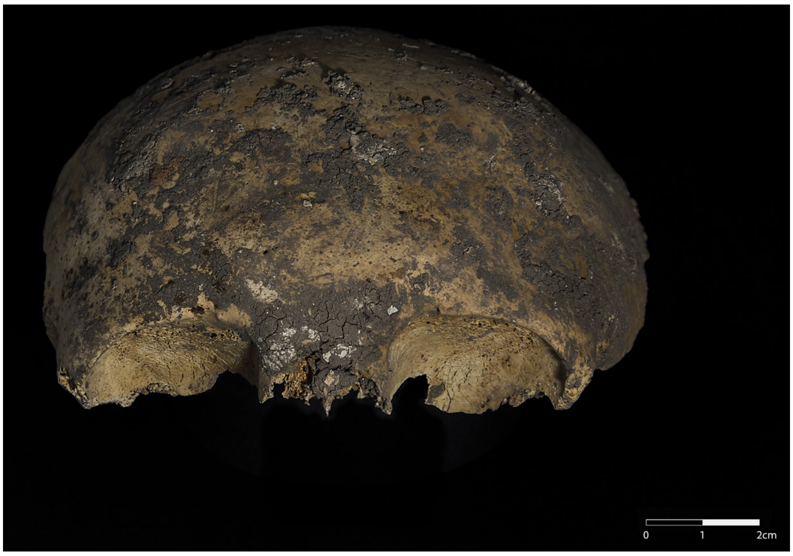

Figure 100 Skull (left and right frontal bone) of post-medieval adolescent male from main chamber in Moneen Cave (Thorsten Kahlert).

Figure 101 Remains of post-medieval adolescent male from niche in Moneen Cave (Quentin Cowper).

Figure 102 Small foot bones from the niche, indicating that this was the original location of the corpse (Thorsten Kahlert).

was almost certainly his first language, and his religion almost certainly Catholic.

- He was short for his age. At just 124.6cm (4ft. 1in.) in height, he was the equivalent of an average 8 year old child by modern standards, or an 11-12 year old by post-medieval standards. This boy would have been noticeably shorter than his contemporaries.
- He was malnourished, probably throughout his life. His diet was largely plant based and high in carbohydrates – probably primarily breads and gruels, with little meat. He was deficient in iron and/or vitamins. If breastfed as an infant, his mother may also have had little meat in her diet.
- He had poor oral hygiene, and possibly poor general body hygiene.
- He may have lived through one or more famines, and almost certainly experienced pronounced and repeated periods of hunger.
- He suffered poor health, probably in infancy, early childhood, and into his teenage years. He probably suffered chronic infections. He had sinusitis, which would have been caused by a respiratory infection.
- He was subjected to chronic and repeated stress, probably throughout his lifetime but certainly between the ages of 5 and 14/16. The type of stress is unclear, but probably a combination of nutritional deficiencies, poor health and infections. This stress seems to have been annual or bi-annual and thus may reflect periods of acute hunger when food sources were particularly scarce, thereby leaving the body open to illness and infection.

- DNA analysis indicates he belonged to haplogroup J, which accounts for 10.7% of the modern population of Ireland. Less is known about the particular sub-haplogroup, J2b1b1, but it clearly indicates a European maternal ancestry for the boy.

Many of the above statements must be couched in 'probabilities', but what is undeniable from the assorted analyses is that this boy lived a very hard life. We can assume a life of poverty and impoverishment, hunger and illness. Curiously, neither the excavations nor the specialist studies could determine the cause of death. In that regard, the following observations can be made:

- The niche was the primary location for the fleshed corpse, supported by the presence of very small skeletal elements (Figure 102).
- The niche is a small artificial space (0.6m x 0.6-0.75m x 0.8m high) that was quarried out in the past (Figures 103-104). It may have been created by Bronze Age people visiting the cave, possibly playing a role in ritual deposition or ritual retreat, and then reused for shelter by the post-medieval boy millennia later. Alternatively, it may have been created in post-medieval times, possibly even by the boy himself, though it is difficult to understand what its purpose may have been at that time. A number of large stones were found beneath the skeleton (Figure 103), which would have been an uncomfortable surface for the boy sitting or lying there.
- The original position of the body within the niche is far from clear as the bones were disturbed post-mortem, probably by an animal. There is some suggestion, however, that the boy was sitting upright in the niche with his back against the back wall and his legs bent with knees to chest (Figure 106). A slightly less likely scenario, based on the position of the disturbed bones, is that he was in a crouched position within the niche, with his back against the back wall of the niche and clasping his folded legs to his chest.
- The head became separated from the body at some stage in decomposition, while the cranial bones were still held together by soft tissue. An animal such as a fox, wolf or dog was the most likely culprit. If the boy had been sitting upright in the niche, the head would have fallen/tumbled forward following death and/or as decay set in. It would thus have been more accessible to a carnivore, and could have been easily tugged apart from the neck vertebrae. This also implied that the cave entrance was open to the extent that it allowed an animal to jump down into the chamber and jump back out. It is difficult to imagine an

FIGURE 103 VIEW FROM CAVE ENTRANCE OF NICHE ARTIFICIALLY LIT UP WITH ROCK A TO RIGHT (KEN WILLIAMS).

Figure 104 Close-up of niche under artificial lighting (Ken Williams).

animal successfully jumping or clambering out of the cave, but it is not impossible. Alternatively, it may have been unsuccessful and may have died in the cave, though no full carcasses of animals such as wolf, fox or dog were found during excavations.

Cause of death

At present we do not know what led to this boy's death or the circumstances that led to his remains occurring in Moneen Cave. There was no evidence of violence on the skeleton, and no indication as to the cause of death. No artefacts or ecofacts were found associated with the remains. Nothing else from the cave has thus far been attributed to the post-medieval period. As to be expected, the cave is not mentioned in any written accounts from this period. The location of the cave just a few metres from the boundary of the adjacent Dangan townland may be significant, though little can be said in that regard based on current evidence. A number of possibilities are explored here, ending with the theory I am most disposed towards.

Clandestine burial. This boy may have died by suicide or disease and was not afforded a formal Christian burial, but was 'buried' in a secret and isolated location by his family or community. This hypothesis is difficult to sustain because the majority of burials outside formal cemeteries and in children's burial ground – *cillíní*, were placed in an extended position orientated east-west. Furthermore, a children's burial ground is located less than 1km to the east-southeast at Kilweelran, though this was not necessarily operational as a *cillín* at the time of the boy's death (Figure 105).

Dumped or hidden murder victim. Despite the absence of signs of violence on the skeletal remains, it is possible that this boy was a victim of violence and this his body was hastily concealed in the cave. Negating against this theory, however, is the fact that the entrance was not subsequently blocked (as a scavenger was able to enter), which would have been a quick and easy method of ensuring the body was never recovered. Furthermore, the body was not simply dumped into the cave which would have been the most practical was to dispose of a victim, but occurred in the niche. This does not make sense in terms of hiding a murder victim, particularly as the niche was not blocked up.

Death while sheltering in the cave. The most likely scenario based on the present evidence is that this boy died in the cave. He was probably seeking shelter in the cave, crept into the niche, and died there (Figure 106). He may have died from starvation, hypothermia, illness or injury – or a combination of these. There is no evidence that he lived in the cave for any period of time, though such evidence may not have survived in

Figure 105 Sites and Monuments Record showing location of Moneen Cave. Fulachtaí fia indicated in green.

the archaeological record. He may have been familiar with the cave if he lived nearby, or if he worked on the mountain, perhaps minding sheep if booleying was practised here at that time. Alternatively he may have fortuitously discovered the cave and hidden there if he was fleeing a troubled situation, such as warfare, violence, or religious persecution. We cannot rule out the possibility that this boy was dispossessed and without a family, and was sheltering in the cave for a period of time as his only option. It is also possible that he was not alone when he died, but the lack of effort to lay out the body in a Christian manner, and the fact his remains were never recovered from the cave, all strongly suggest that he died alone and that no one knew when or where he had died.

Parallels

There are few parallels for the human skeleton from Moneen Cave. Recent analyses of human bones and artefacts from Irish caves reveals virtually no sites with evidence of post-medieval activities (Dowd 2015). One exception is Kilgreany Cave, Co. Waterford where a coin, token, pottery and clay pipe fragments point to use of the cave as a hideout by an individual of means in the late 17th century (McCutcheon 2016). Finds like these support the widespread folklore associations between caves and people (typically men) who used caves as refuges and hideouts during political upheaval or religious persecution (Dowd 2015: 233-6). Caves throughout Ireland were used as refuges during the Rebellion of 1641, the 1798 Rebellion, and in Penal times (1690s-1829) (Dowd 2015: 236). Political conflict and religious persecution may account for the human skeletal remains in Moneen Cave and from three other Irish caves – Bats' Cave and Robber's Den in County Clare, and Main Earth Cave, Co. Cork. At these three sites, however, only isolated bones rather than complete or near complete skeleton were encountered. An adolescent tibia from Bats' Cave, 34km south of Moneen Cave, was dated to 270±40BP (Beta-277395), 1486-1676 cal AD (Dowd 2015: 213). The age of the individual and the radiocarbon date mirror the Moneen Cave boy, but there are no indications of a complete corpse at Bats' Cave. An

Figure 106 Reconstruction of adolescent boy in the niche in Moneen Cave (J. G. O'Donoghue).

adult tibia from Robber's Den, 16km west-southwest of Moneen Cave, returned another similar date of 320±40 BP (Beta-277383), 1468-1649 cal AD (Dowd 2015: 213). Like Moneen Cave, Robber's Den is a secluded and inconspicuous site that would have made an ideal refuge, but it is difficult to interpret what a single bone represents. Finally, an adult tibia from Main Earth Cave was radiocarbon dated to 306±32 BP (UBA-6678), 1484-1653 cal AD and may relate directly or indirectly to a nearby Cromwellian attack (Dowd 2015: 213).

Human bones of similar date to the Moneen Cave skeleton have been recovered at Caherconnell some 8km to the south-southwest. The partial and disarticulated remains of an adolescent who was about 15 or 16 years old when s/he died had been placed in the doorway of a collapsed medieval drystone structure. This individual, like the boy from Moneen Cave, had signs of cribra orbitalia suggesting nutritional deficiencies, and s/he had a healed rib fracture (Tesorieri 2009). A rib from the adolescent returned a date of 400±40 BP (Beta-249136), which calibrates to AD 1420-1640 (Michelle Comber pers. comm.). The Caherconnell adolescent appears to have been a secondary deposit within the doorway of the structure. It is possible that agricultural acivities disturbed a burial and the exposed bones were collected and redeposited (Michelle Comber pers. comm.). That said, the relative completeness of the skeleton suggests the possibility that s/he represents a burial in or around the cashel, essentially another unusual and non-Christian place that parallels to some extent the Moneen Cave find.

While ringforts and cashels are seen as typical settlements of the early medieval period, it is clear that in the Burren and elsewhere many such sites continued to be occupied during the high medieval period and into post-medieval times (Fitzpatrick 2009; Jones 2004: 110-3; O'Conor 1998; O'Sullivan 1998). A ringfort (CL002-057----), cashel (CL005-056----) and possible cashel (CL005-058----) are situated within 1.5km of Moneen Cave and several other unspecified enclosures mentioned below are also likely to be contemporaneous. Though the adolescent from Moneen Cave likely post-dates the final occupation of these early medieval sites, an association is not impossible. Also relevant is the presence of at least three graveyards and ecclesiastical sites of medieval and post-medieval date in the wider environs of the cave. Killoghil graveyard (CL002-059----) and the ecclesiastical remains and graveyard at Bishopsquarter (CL002-014----) are located to the north, and a children's burial ground and enclosure (CL006-003----) lie at Kilweelran, less than 1km to the east-southeast. Further archaeological sites undoubtedly remain to be discovered in this relatively unexplored upland landscape – particularly to the north and northeast of the cave. More detailed survey and excavation of existing monuments is also required to determine their date, considering the large number of undefined 'enclosures' of uncertain date such as the four enclosures to the northwest of the cave (CL002-058----, -060----, -061----, -015----), one to the southwest (CL005-057----), and seven to the southeast (CL006-004----, -005----, -006----, -007----, -009----, -012----, -013----).

Early Ordnance Survey maps of Acres townland indicate several sheepfolds and a well – *Tobercullen* – near Moneen Cave, all supporting evidence that these uplands were used in recent centuries for animal grazing and farming. In the 19th century the nearest concentration of settlement was Acres village under 1km west-northwest of the cave (Figures 5 and 7). It is now no longer a village, but it may have existed during the lifetime of the Moneen Cave boy. He and the vast majority of his contemporaries lived hard lives, eking a meagre living from the land. Famine and hunger were not uncommon experiences, nor were illnesses and early death. In many respects there is nothing unique about the adolescent from Moneen Cave. In fact, he could be seen as a typical representation of the lives endured by many people during the period. That should not detract, however, from the poignancy of his life as told by the archaeological and scientific analyses.

26. Public archaeology and Moneen Cave

Over the past three decades there has been a growing awareness amongst the archaeological profession in Ireland and globally of the need to disseminate the results of archaeological research and excavations to the general public, not least because the majority of archaeological work is ultimately funded by the public (Merriman 2004; Skeates *et al*. 2012). Public engagement is also, however, essential in promoting awareness and education, conservation and heritage, and for local economies dependent on tourism.

The Moneen Cave excavation was just two weeks in length and only received a few visitors, partly due to time limits and a difficult environment. However, a series of public lectures and publications aimed at non-archaeologists has brought the site to much wider attention and has fostered a local awareness of, and interest in, the cave and its archaeological deposits. Summaries of the excavation were published in *Burren Insight* – the magazine of the conservation and education organisation, Burren Beo (Dowd 2012b); *The Other Clare* – the journal of the Shannon Archaeological and Historical Society focussing on County Clare (Dowd 2013b); *Archaeology Ireland* – the principal Irish archaeology magazine (Dowd 2013a); and *Descent* – the principal British caving magazine (Casserly and Dowd 2011).

To complement these publications, lectures were presented to reach local and national, public and academic, audiences. These included lectures at Ballyvaughan National School, the school closest to Moneen Cave (Figure 107). From local to global, one month earlier the hammerhead/macehead from Moneen Cave formed the centrepiece of an archaeological exhibition to showcase Ireland's heritage during a visit from HRH Prince Charles of Wales to IT Sligo which was broadcast globally (Figure 108). Lectures on the excavations were also delivered to archaeological student societies at the National University of Ireland, Galway and IT Sligo. Two public lectures were aimed at the local community and archaeology enthusiasts, and both events were packed to capacity proving a high level of local interest in the excavations.

Significant regional and national interest grew in the twelve months after the excavation, leading to radio interviews in counties Clare and Sligo and numerous articles in national and regional press during 2012 and 2013. Public interest in Moneen Cave was particularly illuminating considering that, from an archaeological perspective, the discoveries in the cave were interesting but not necessarily ground-breaking. From a non-archaeological perspective there were no 'spectacular' artefacts, yet the site captured the public imagination. Clearly archaeological discoveries that are well-communicated to a wider audience are more effective than poorly-communicated 'rich' sites in terms of building local pride and interest in heritage, thereby helping in the long-term preservation and conservation of archaeological and historic sites.

Probably the most significant aspect of the Moneen Cave excavation in terms of public outreach is that it prompted the production of a leaflet by the Department of Arts, Heritage and the Gaeltacht together with the National Museum of Ireland, with input by this writer, called *Advice to the public on the archaeological potential of caves* (Figure 109). This is the first brochure of its kind in Europe and covers questions regarding the specialised archaeological environment of caves, such as:

- What is a cave?
- When is a cave an archaeological monument?
- What type of archaeological material occurs in Irish caves?
- What is the difference between palaeontological and archaeological discoveries in caves?

Figure 107 Marion Dowd giving a talk on Moneen Cave to the children in Ballyvaughan National School, June 2015 (Terry Casserly, with permission of the school).

Figure 109 NMS and NMI leaflet *Advice to the public on the archaeological potential of caves*.

Figure 108 HRH Prince Charles of Wales examines the antler hammerhead/macehead from Moneen Cave at IT Sligo, May 2015 (James Connolly).

- Can I dig in a cave where there are known archaeological remains?
- What should I do if I find archaeological material in a cave?

The leaflet is grounded in Irish archaeological legislation and is available as a PDF (www.archaeology.ie). The printed version was launched by Pauline Gleeson, Senior Archaeologist with the NMS, at the annual Speleological Union of Ireland symposium in October 2014. Moneen Cave has in many ways served to strengthen communication and cooperation between the archaeological and caving communities in Ireland. It was the first cave excavation in Ireland to comprise a team of cavers and archaeologists (Figure 110) and hopefully paves the way for future collaboration when caves are targeted for archaeological investigation.

27. Future work

Rescue excavations at Moneen Cave in 2011 involved the removal of *ex situ* and exposed archaeological deposits and bones from the lower reaches of the cave and approximately 45% of the area of the cave chamber was excavated. However, only the uppermost strata were removed and throughout the chamber archaeological strata remain undisturbed. Approximately 55% of the cave chamber has not been excavated, specifically the western part which is now protected beneath caver's rubble (C.5). There is no need to investigate this area under a rescue remit, though research excavations in the future may help clarify the nature of activities in the cave during the Bronze Age and in post-medieval times. Future excavations may also aid in determining whether there was a Neolithic phase of activities at the site.

Figure 110 The Moneen Cave excavation team comprised cavers and archaeologists: Tim O'Connell, Clodagh Lynch, Quentin Cowper, Elaine Lynch, Marion Dowd, Michael Lynch, and Terry Casserly.

The entire Moneen assemblage – human remains, faunal remains, ecofacts and artefacts – were deposited in the NMI for long-term storage in October 2016. This material is available for future studies and will no doubt provide new information as new scientific techniques emerge and are applied. Additional radiocarbon dates on the animal bones (cattle and hare in particular) may reveal further evidence of human activities. The portion of the faunal assemblage that is not of anthropogenic origin is likely to be of significance in terms of the Burren fauna. The corncrake, for instance, no longer exists in the Burren but four corncrake bones were recovered from Moneen Cave (Section 10).

The value of the excavation at Moneen Cave is that it provides an opportunity to discuss the role of caves as foci of Bronze Age ritual in the Burren and further afield, and highlight the role of 'regular' domestic material (pottery, shells and meat) in votive deposition. The antler hammerhead/macehead highlights the need for more detailed research on this neglected artefact type in Ireland, and the role of antler in Bronze Age society. The site supports wider European evidence for the significance of natural places in prehistoric landscapes, and the perception of caves as places associated with the religious rather than the secular dimension of Bronze Age life. The post-medieval skeletal remains have provided an opportunity to closely examine the life and seemingly poignant death of one individual. What has been elucidated about the life of this unnamed boy provides an insight into the experiences of thousands of children and adolescents in Ireland over the past 500 years.

28. References

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Appendix 1
Context register

Context	Level	Type	Description	Dimensions (maximum)	Artefacts and radiocarbon dated material	Environmental material
1	2	Deposit	Surface deposit of loose material, fallen down from Level 1. Greyish brown silty clay with flecks of white calcite. Moderate inclusions of small to large angular stones, small inclusions of snail shells and calcite. Disturbed and trampled. Only partially excavated. Overlying C.3.	0.85m x 0.68m x 0.15m deep	EBA pig pelvis MBA-LBA oyster shell MBA-LBA pottery (V1, V2, V4, V5, V6): 11E0316:01:03-34, 75-76, 151-161 Modern 10c coin	701 animal bones: 12 sheep/goat; 1 pig; 1 hare/lagomorph; 1 mouse; 1 frog; 9 foetal animal bones; 76 bones various sized mammals (including one rib with cutmarks); 3 bird bones (passerine); 597 unidentifiable 1 oyster shell
2	6	Deposit	A pocket of 29 pottery sherds and 2 crumbs found amongst gaps in the limestone rubble. Pottery had fallen down from cave chamber.	1.2m x 0.8m general area of spread	MBA-LBA pottery (V1, V5, V6): 11E0316:02:35-58, 61-62, 64, 73, 162, 180	3 animal bones: unidentifiable
3	2	Deposit	Firm mid-brown silty clay. Occasional inclusions of angular stones, moderate snail shells and calcite. Probably percolated down from cave chamber in antiquity. Only partially excavated. Under C.1, over C.13.	0.74m x 0.65m x 0.06m deep	Flint blade: 11E0316:03:163 MBA-LBA pottery (V1, V5): 11E0316:03:60, 65, 178, 179	381 animal bones: 2 cattle; 4 sheep/goat; 23 hare/lagomorph; 10 mouse; 2 foetal animal bones; 28 bones various sized mammals; 1 duck bone; 10 passerine bird bones, 300 unidentifiable Small quantity of charcoal
4	5	Deposit	Deposit created by cavers when digging a passageway down to Level 2. Probably originally part of C.15 and/or C.16. Beside Rock B, between cave chamber and start of passageway. A rubble deposit set in loose mid brown silty clay (60% stone, 40% soil). Occasional inclusions of small angular stones and snail shells. Contained cartridge from rock blasting by cavers.	1.05m x 0.6m x 0.32m	MBA-LBA pottery (V1, V5): 11E0316:04:183, 185, 186, 192-194, 199-204, 206 Post-medieval human bones	109 human skull fragments 37 animal bones: 6 medium sized mammal; 31 unidentifiable 1 oyster shell 2 frags. of charcoal
5	1	Deposit	Loose deposit of large and angular stones. Consists of rubble dug up by cavers to access lower levels. It was piled up around the walls of the cave chamber.	3.2m x 2.8m x 1m		7 animal bones: 3 large mammal; 4 unidentifiable
6	1	Deposit	Loose dark brown friable and organic silty clay with occasional small stones and pebbles. Occurred on a rock above Rock B by cave entrance. Modern accumulation, possibly from animal burrowing. Appears to relate to activities outside the cave. Animal bones and a fresh goat skull were collected from this area and originally given C.17, but bagged as C.6.	0.55 x 0.5 x 0.07m deep		23 animal bones: intact juvenile goat skull (categorised as 4 pieces); 2 mammal bones; 17 unidentifiable
7	7	Deposit	A vertical drop of loose and crumbly mid-greyish brown rich silty clay above the opening into Level 3. Occasional to moderate inclusions of calcite flecks, small stones and pebbles, frequent snail shells and frequent animal bone. More calcite at lower end of deposit. Seems to have percolated down from the area of Rock B – possibly spill from C.12 and/or C.11, and probably of recent origin.	0.5m x 0.6m x 0.3m deep		593 animal bones: 1 cattle; 54 sheep/goat; 2 mouse; 1 rat; 1 frog; 372 bones various sized mammals; 2 corncrake; 1 rook/crow; 1 duck; 158 unidentifiable Small frags. of charcoal

8	8	Deposit	Three sherds of pottery found amongst rubble, on a ledge wedged between stones, under Rock B. Most likely percolated down from Level 1.	0.5m x 0.3m general area of spread	MBA-LBA pottery: 11E0316:08:59, 63, 165	
9	3	Deposit	Loose mid-brown silty clay with frequent inclusions of small angular stones and pebbles. Occurred in Level 3 and seems to be a mix of C.7 and also archaeological deposits that were dislodged from the cave passage (Level 2).	0.6m x 0.5m x 0.2m deep	LBA large mammal rib with butchery marks	38 animal bones: 7 sheep/goat; 27 bones various sized mammals (including one rib with cutmarks); 4 unidentifiable 1 oyster shell
10	4	Deposit	Deposit of large and medium-sized stones within a matrix of loose greyish brown silty clay (70% stone, 30% clay). This is a mix of disturbed archaeological strata mixed with recent material that has percolated down from upper levels, probably including part of C.12.	0.8 x 0.5 x 0.2m deep	Neolithic bear cub femur MBA-LBA pottery (V1, V5): 11E0316:10:166-176	354 animal bones: 33 sheep/goat; 6 hare/lagomorphs; 1 cat; 1 mouse; 55 bones various sized mammals; 1 duck, 10 passerine bird (some fragmented); 4 unidentifiable bird; 241 unidentifiable Small frags. of charcoal
11	1	Deposit	Loose to firm mid-greyish brown silty clay. Thin layer of soil on surface of Rock B. This was the original caver access route to lower levels and thus C.11 has been disturbed and likely dispersed. This context is probably relatively recent in origin.	0.9 x 0.6 x 0.01m deep		4 animal bones: 1 mouse, 1 small mammal, 2 unidentifiable
12	9	Deposit	Loose mid-brown silty clay with occasional angular stones and pebbles to south of Rock B. May have percolated down from outside cave associated with animal burrowing. Similar to C.11 and also probably relatively recent in origin. Has been trampled and dispersed as it occurred on the surface of the original route used by cavers to access deeper levels of cave.	0.78m x 0.35m x 0.25m deep		173 animal bones: 1 cattle; 1 sheep/goat; 1 hare/lagomorph; 1 mouse; 1 frog; 21 bones various sized mammals; 2 corncrake; 1 duck; 2 passerine bird; 142 unidentifiable Small quantity of charcoal
13	2	Deposit	Firm yellowish brown clay with calcite flecks, frequent snail shells and occasional stone. Under C.3, sealed unexcavated rubble layer.	0.7m x 0.6m x 0.1m deep	MBA-LBA pottery (V1): 11E0316:13:181, 184	64 animal bones: 2 sheep/goat; 3 hare/lagomorph; 1 rat; 15 bones various sized mammals; 43 unidentifiable Small fragment of oyster shell One piece of charcoal
14	3	Deposit	Effectively C.9 that was knocked into deeper levels of the cave during the archaeological excavation. Possibly includes part of C.7.		MBA-LBA pottery: 11E0316:14:182	134 animal bones: 5 sheep/goat; 1 bat; 46 bones various sized mammals; 82 unidentifiable
15	1	Deposit	Uppermost stratum, quite disturbed. Possibly original surface prior to caver activities. Likely that C.15 and C.18 are the same stratum, but stones in the latter were larger in size. A layer of limestone rubble set in a firm to loose mid-brown silty clay (*c.* 60% rubble, 40% clay) with moderate inclusions of snail shells and shattered stone. It occurred between Rock A to the east and caver's rubble (C.5) to the west. Southern removed by caver activity. Over C.16.	1.52m x 0.54m x 0.13m deep	MBA-LBA pottery (V4, V5): 11E0316:15:77, 187-191, 195-198 Post-medieval human bones	3 human bones 86 animal bones: 1 cattle; 7 sheep/goat; 1 rat; 12 bones various sized mammals; 2 passerine bird bones; 63 unidentifiable Small fragment of oyster shell

16	1	Deposit	Stoney layer set in a firm mid-brown silty clay (50% stone, 50% sediment) with frequent snail shells. Occurs to west of Rock A. More sediment in southern part, in northern part stones with gaps and hollows so that sediment percolating down to deeper levels. Under C.15 and C.18.	1.52m x 0.54m x 0.21m	MBA-LBA pottery: 11E0316:16:205	33 animal bones: 3 small shark/ray; 30 unidentifiable Charcoal flecks
17	1	Number given to goat skull found outside cave entrance, but this and other animal bones were bagged on-site as C.6.				
18	1	Deposit	Uppermost stratum, somewhat disturbed by cavers. Filled entire area of chamber. Not fully excavated. Original surface prior to caver activities as many stones were moss-covered. Seems to be the same layer as C.15, but stones in the latter were smaller. A layer of limestone rubble (90% stones, 10% soil) set in a firm brownish grey silty clay with calcium carbonate inclusions. Sealed C.19 and C.16.	Excavated portion 1.4m x 1.46m. E of Rock A - 0.94m x 0.5m x 0.54m deep	MBA-LBA pottery (V1): 11E0316:18:207, 209 Sandstone stone	107 animal bones: 2 sheep/goat; 3 hare/lagomorph; 9 bones various sized mammals; 1 passerine bird bone; 91 unidentifiable
19	1	Deposit	Firm greyish brown silty clay with inclusions of angular stones, small shattered stone, flecks of calcite and snail shells. Occurs to west and south of Rock A, under C.18.	0.94m x 0.64m x 0.17m deep	MBA antler fragment MBA-LBA pottery (V2, V3, V6): 11E0316:19:66-69, 74, 78, 210-223	110 animal bones: 2 sheep/goat; 1 deer; 5 hare/lagomorph; 2 mouse; 9 bones various sized mammals; 4 chicken (2 in several frags.); 84 unidentifiable One piece of charcoal
20	1	Deposit (Niche)	Moderately firm mid-brown silt with inclusions of small stones, medium stones, frequent calcite chunks, and snail shells. Located within niche. Entirely bulk sampled and sieved in laboratory conditions. Human skeleton contained on and in this stratum. Sealed C.21.	0.6m x 0.6m x 0.3m deep	Post-medieval human skeleton	Human skeleton 162 animal bones: 1 sheep/goat; 2 mouse; 1 frog; 36 bones various sized mammals; 1 passerine bird; 121 unidentifiable Flecks of charcoal
21	1	Deposit (Niche)	Several limestone stones beneath human skeleton, mostly in north side of niche. Some smaller bones had trickled down from C.20 through C.21 and rested on C.22.	0.6 m x 0.75m x 0.25m thick		
22	1	Deposit (Niche)	Firm brown silty clay with frequent calcite lumps. Exposed beneath C.21 on floor of niche. It was exposed and trowelled down but not excavated. It remains *in situ*, sealed by geo-textile membrane.	0.6 m x 0.75m	Post-medieval human bones	8 human bones 67 animal bones: 9 mouse; 9 small mammal; 49 unidentifiable One piece of charcoal

Appendix 2
Finds register

Artefacts discovered by cavers prior to the archaeological excavation in June 2011 were given the context number 0X. Finds made by cavers after the excavation, namely in September 2011 and February 2013, were given the context number XX. Both groups are listed here as *caver find* and are effectively *ex situ*. The National Museum of Ireland artefact databases can only accept numerals, hence for their databases 0X was converted to 0, and XX was converted to 99.

No find numbers were allocated from 78 to 149 inclusive. Thus the list goes from 1 to 76, then 150 to 251. None of the artefacts have been conserved, and at the time of writing do not require conservation.

Find no.	Level	Context	Description
11E0316:0X:01	2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:02	2	Caver find - June 2011	Rim sherd of MBA/LBA pottery, V.1
11E0316:01:03	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:04	2	1	Base angle sherd of MBA/LBA pottery, V.5
11E0316:01:05	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:06	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:07	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:08	2	1	Crumbs (18) of MBA/LBA pottery
11E0316:01:09	2	1	Body sherd of MBA/LBA pottery, V.1
11E0316:01:10	2	1	Body sherd of MBA/LBA pottery, V.5
11E0316:01:11	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:12	2	1	Rim sherd of MBA/LBA pottery, V.1
11E0316:01:13	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:14	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:15	2	1	Small fragment of MBA/LBA pottery, V.5
11E0316:01:16	2	1	Body sherd of MBA/LBA pottery, V.5
11E0316:01:17	2	1	Body sherd of MBA/LBA pottery, V.4
11E0316:01:18	2	1	Small fragment of MBA/LBA pottery, V.5
11E0316:01:19	2	1	Crumbs (27) of MBA/LBA pottery
11E0316:01:20	2	1	Base sherd of MBA/LBA pottery, V.5
11E0316:01:21	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:22	2	1	Small fragment of MBA/LBA pottery, V.5
11E0316:01:23	2	1	Body sherd of MBA/LBA pottery, V.5
11E0316:01:24	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:25	2	1	Base angle sherd of MBA/LBA pottery, V.5
11E0316:01:26	2	1	Body sherd of MBA/LBA pottery, V.5
11E0316:01:27	2	1	Body sherd of MBA/LBA pottery, V.5
11E0316:01:28	2	1	Small fragment of MBA/LBA pottery, V.6
11E0316:01:29	2	1	Rim sherd of MBA/LBA pottery, V.2
11E0316:01:30	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:31	2	1	Small fragment of MBA/LBA pottery, V.6
11E0316:01:32	2	1	Small fragment of MBA/LBA pottery, V.5
11E0316:01:33	2	1	Small fragment of MBA/LBA pottery, V.6
11E0316:01:34	2	1	Crumbs (22) of MBA/LBA pottery
11E0316:02:35	6	2	Sherd of MBA/LBA pottery, near rim with internal bevel, V.1
11E0316:02:36	6	2	Body sherd of MBA/LBA pottery, V.5
11E0316:02:37	6	2	Rim sherd of MBA/LBA pottery, V.1
11E0316:02:38	6	2	Crumbs (3) of MBA/LBA pottery
11E0316:02:39	6	2	Body sherd of MBA/LBA pottery, V.6

11E0316:02:40	6	2	Body sherd of MBA/LBA pottery, V.6
11E0316:02:41	6	2	Base-angled sherd of MBA/LBA pottery, V.1
11E0316:02:42	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:43	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:44	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:45	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:46	6	2	Small fragment of MBA/LBA pottery, V.1
11E0316:02:47	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:48	6	2	Crumbs (7) of MBA/LBA pottery
11E0316:02:49	6	2	Small fragment of MBA/LBA pottery, V.1
11E0316:02:50	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:51	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:52	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:53	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:54	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:55	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:02:56	6	2	Body sherd of MBA/LBA pottery, V.5
11E0316:02:57	6	2	Body sherd of MBA/LBA pottery, V.6
11E0316:02:58	6	2	Base sherd of MBA/LBA pottery, V.5
11E0316:08:59	8	8	Small fragment of MBA/LBA pottery, V.5
11E0316:03:60	2	3	Small fragment of MBA/LBA pottery, V.1
11E0316:02:61	6	2	Crumbs (16) of MBA/LBA pottery
11E0316:02:62	6	2	Rim sherd of MBA/LBA pottery, V.1
11E0316:08:63	8	8	Small fragment of MBA/LBA pottery, V.5
11E0316:02:64	6	2	Sherd of MBA/LBA pottery, near rim with internal bevel, V.1
11E0316:03:65	2	3	Body sherd of MBA/LBA pottery, V.1
11E0316:19:66	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:67	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:68	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:69	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:01:70	Number cancelled (10c coin)		
11E0316:04:71	Number cancelled (brass blasting cartridge)		
11E0316:05:72	Number cancelled		
11E0316:02:73	6	2	Small fragment of MBA/LBA pottery, V.1
11E0316:19:74	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:01:75	2	1	Crumbs (4) of MBA/LBA pottery
11E0316:01:76	2	1	Small fragment of MBA/LBA pottery, V.5
11E0316:15:77	7	15	Small fragment of MBA/LBA pottery, V.5
11E0316:19:78	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:01:150	Number cancelled		
11E0316:01:151	2	1	Body sherd of MBA/LBA pottery, V.2
11E0316:01:152	2	1	Small fragment of MBA/LBA pottery, V.6
11E0316:01:153	2	1	Body sherd of MBA/LBA pottery, V.5
11E0316:01:154	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:155	2	1	Base angle sherd of MBA/LBA pottery, V.5
11E0316:01:156	2	1	Body sherd of MBA/LBA pottery, V.5
11E0316:01:157	2	1	Body sherd of MBA/LBA pottery, V.4
11E0316:01:158	2	1	Body sherd of MBA/LBA pottery, V.6
11E0316:01:159	2	1	Small fragment of MBA/LBA pottery, V.6
11E0316:01:160	2	1	Crumbs (45) of MBA/LBA pottery
11E0316:01:161	2	1	Small fragment of MBA/LBA pottery, V.5
11E0316:02:162	6	2	Crumbs (3) of MBA/LBA pottery
11E0316:03:163	2	3	Flint flake, broken
11E0316:11:164	Number cancelled		

11E0316:08:165	8	8	Body sherd of MBA/LBA pottery, V.6
11E0316:10:166	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:10:167	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:10:168	4	10	Body sherd of MBA/LBA pottery, V.1
11E0316:10:169	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:10:170	4	10	Body sherd of MBA/LBA pottery, V.5
11E0316:10:171	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:10:172	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:10:173	4	10	Small fragment of MBA/LBA pottery, V.5
11E0316:10:174	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:10:175	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:10:176	4	10	Small fragment of MBA/LBA pottery, V.1
11E0316:01:177	Number cancelled		
11E0316:03:178	2	3	Body sherd of MBA/LBA pottery, V.5
11E0316:03:179	2	3	Body sherd of MBA/LBA pottery, V.5
11E0316:02:180	6	2	Body sherd of MBA/LBA pottery, V.1
11E0316:13:181	2	13	Crumbs (2) of MBA/LBA pottery
11E0316:14:182	3	14	Crumbs (2) of MBA/LBA pottery
11E0316:04:183	5	4	Body sherd of MBA/LBA pottery, V.1
11E0316:13:184	2	13	Small fragment of MBA/LBA pottery, V.1
11E0316:04:185	5	4	Small fragment of MBA/LBA pottery, V.1
11E0316:04:186	5	4	Body sherd of MBA/LBA pottery, V.1
11E0316:15:187	1	15	Rim sherd of MBA/LBA pottery, V.4
11E0316:15:188	1	15	Body sherd of MBA/LBA pottery, V.5
11E0316:15:189	1	15	Base angle sherd of MBA/LBA pottery, V.5
11E0316:15:190	1	15	Small fragment of MBA/LBA pottery, V.5
11E0316:15:191	1	15	Crumbs (4) of MBA/LBA pottery
11E0316:04:192	5	4	Sherd of MBA/LBA pottery, near rim with internal bevel, V.1
11E0316:04:193	5	4	Small fragment of MBA/LBA pottery, V.5
11E0316:04:194	5	4	Small fragment of MBA/LBA pottery, V.1
11E0316:15:195	1	15	Crumb (1) of MBA/LBA pottery
11E0316:15:196	1	15	Small fragment of MBA/LBA pottery, V.5
11E0316:15:197	1	15	Small fragment of MBA/LBA pottery, V.5
11E0316:15:198	1	15	Rim sherd of MBA/LBA pottery, V.4
11E0316:04:199	5	4	Small fragment of MBA/LBA pottery, V.1
11E0316:04:200	5	4	Small fragment of MBA/LBA pottery, V.5
11E0316:04:201	5	4	Small fragment of MBA/LBA pottery, V.1
11E0316:04:202	5	4	Small fragment of MBA/LBA pottery, V.1
11E0316:04:203	5	4	Small fragment of MBA/LBA pottery, V.1
11E0316:04:204	5	4	Crumbs (21) of MBA/LBA pottery
11E0316:16:205	1	16	Crumb (1) of MBA/LBA pottery
11E0316:04:206	5	4	Small fragment of MBA/LBA pottery, V.1
11E0316:18:207	1	18	Sherd of MBA/LBA pottery, near rim with internal bevel, V.1
11E0316:18:208	Number cancelled		
11E0316:18:209	1	18	Crumb (1) of MBA/LBA pottery
11E0316:19:210	1	19	Sherd of MBA/LBA pottery, near rim with internal bevel, V.2
11E0316:19:211	1	19	Rim sherd of MBA/LBA pottery, V.6
11E0316:19:212	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:213	1	19	Rim sherd of MBA/LBA pottery, V.3
11E0316:19:214	1	19	Rim sherd of MBA/LBA pottery, V.6
11E0316:19:215	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:216	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:217	1	19	Small fragment of MBA/LBA pottery, V.6

11E0316:19:218	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:219	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:220	1	19	Crumbs (2) of MBA/LBA pottery
11E0316:19:221	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:222	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:19:223	1	19	Body sherd of MBA/LBA pottery, V.6
11E0316:0X:224	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:225	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:226	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:227	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:228	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:229	1/2	Caver find - June 2011	Base sherd of MBA/LBA pottery, V.5
11E0316:02:230	2	2	Small fragment of MBA/LBA pottery, V.1
11E0316:0X:231	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:232	1/2	Caver find - June 2011	Base sherd of MBA/LBA pottery, V.5
11E0316:0X:233	1/2	Caver find - June 2011	Base sherd of MBA/LBA pottery, V.5
11E0316:0X:234	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:235	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:236	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:237	1/2	Caver find - June 2011	Base sherd of MBA/LBA pottery, V.5
11E0316:0X:238	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:239	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:240	1/2	Caver find - June 2011	Rim sherd of MBA/LBA pottery, V.3
11E0316:0X:241	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:242	1/2	Caver find - June 2011	Base angle sherd of MBA/LBA pottery, V.5
11E0316:0X:243	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:244	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:245	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:246	1/2	Caver find - June 2011	Base sherd of MBA/LBA pottery, V.5
11E0316:0X:247	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.6
11E0316:0X:248	1/2	Caver find - June 2011	Body sherd of MBA/LBA pottery, V.5
11E0316:0X:249	1/2	Caver find - June 2011	Base angle sherd of MBA/LBA pottery, V.5
11E0316:0X:250	1/2	Caver find - June 2011	Base angle sherd of MBA/LBA pottery, V.5
11E0316:XX:251	2	Caver find - Sept. 2011	Body sherd of MBA/LBA pottery, V.1
11E0316:0X:252	2	Caver find - June 2011	Perforated antler hammerhead/macehead
11E0316:20:253	1	20	Human skeleton
11E0316:XX:254	2	Caver find - Feb. 2013	Body sherd of MBA/LBA pottery, V.1
11E0316:XX:255	2	Caver find - Feb. 2013	Body sherd of MBA/LBA pottery, V. 1
11E0316:XX:256	2	Caver find - Feb. 2013	Body sherd of MBA/LBA pottery, V.1
11E0316:XX:257	2	Caver find - Feb. 2013	Body sherd of MBA/LBA pottery, V.1
11E0316:XX:258	2	Caver find - Feb. 2013	Body sherd of MBA/LBA pottery, V.1
11E0316:XX:259	2	Caver find - Feb. 2013	Body sherd of MBA/LBA pottery, V.1
11E0316:XX:260	2	Caver find - Feb. 2013	Base angle sherd of MBA/LBA pottery, V.1
11E0316:XX:261	2	Caver find - June 2015	Body sherd of MBA/LBA pottery, V.5

Appendix 3
Mammalian faunal remains by context

Fiona Beglane

Context	No. of fragments	Total identifiable excl. bird and fish	Cattle	Sheep/Goat	Pig	Red deer	Hare/Lago	Cat	Bear	Mouse	Rat	Bat	Frog	Foetus/Neonate	LM	LM/MM	MM	SM	VSMB
0X	16	15	2	5											6		2		
1	701	101		12	1		1			1			1	9	15	1	54	2	4
2	3	3													1		2		
3	380	69	2	4			23			10				2	8		16	4	
4	37	5															5		
5	7	3													3				
6	23	6		4											2				
7	593	431	1	54						2	1		1		2	355	7	4	4
9	38	34		7											2	2	23		
10	354	97		33			6	1	1	1					4	6	37	7	1
11	4	2								1									1
12	173	26	1	1			1			1			1		1	2	3	6	9
13	65	21		2			3				1				1		8	6	
14	134	52		5								1			4	1	41		
15	86	21	1	7							1						11		1
16	33	0																	
17/18	22	6		1													5		
18	85	9		1			3										1	4	
19	110	19		2		1	5			2					3		1	5	
20	162	40		1						2			1		1		1	6	28
20/22	33	10					1			2								4	3
22	67	18								9								4	5
Total	3,126	988	7	139	1	1	43	1	1	31	3	1	4	11	53	367	217	52	56
%		31.6	0.7	14.1	0.1	0.1	4.4	0.1	0.1	3.1	0.3	0.1	0.4	1.1	5.4	37.1	22.0	5.3	5.7

Appendix 4
List of human bones

Catriona McKenzie

During the archaeological excavation, each human bone contained within the niche was allocated a 'Bone no.' when lifting the remains because the skeleton was disturbed. In several cases groups of small bones found together were given the same 'Bone number'. This appendix correlates with Figures 55, 56, 57, 58 and 59 in the main text. Also included here are human bones found elsewhere in the cave, all derive from the same individual. Some numbers were discounted and are thus not listed below.

Bone no.	Skeletal element
1	Left femoral diaphysis
2	Right femoral diaphysis
3	Right tibial diaphysis
4	Right humeral diaphysis
5	Right radial diaphysis
6	Right fibular diaphysis
7	Right femoral distal epiphysis
8	Left ilium
10	Right distal fibular epiphysis
11	Left talus
12	Left calcaneus
13	Left cuboid
14	Left first proximal foot phalanx
15	Proximal epiphysis of first proximal foot phalanx
16	Intermediate foot phalanx
17	Left calcaneal epiphysis
18	Right femoral head epiphysis
19	Right calcaneus
20	Right talus
21	Right distal tibial epiphysis
22	Right proximal femoral diaphysis
24	Right navicular
25	Left femoral head epiphysis
26	Left pubis
27	Left ischium
28	Right first, second and third cuneiform; right cuboid; right second and third metatarsal; right first proximal foot phalanx
29	Fourth sacral vertebra
30	Right pubis and ischium (fused)
31	Right ulnar diaphysis, fragmented in three pieces
33	Right scapula
34	Left radial diaphysis
35	Left humeral diaphysis
37	Mandible
39	Fourth lumbar vertebra
41	First sacral vertebra
42	Right ilium; left side of the first sacral vertebra
46	Right second metacarpal
48	Right proximal radial epiphysis
49	Neural arch of fourth lumbar vertebra
50	Neural arch of fourth lumbar vertebra

51	Second sacral vertebra
52	Third sacral vertebra
53	Fragment of fifth lumbar vertebra
54	Fragment of fifth lumbar vertebra
55	Left ulnar diaphysis
56	Left rib
57	Left rib
60	Left rib; right rib
61	Right rib
63	Proximal hand phalanx
64	Right rib
65	Right proximal humeral epiphysis
66	Fragment of right scapula
67	Fragment of right scapula
68	Left distal femoral epiphysis
71	Left tibial diaphysis; left proximal tibial epiphysis; left tibial tuberosity
72	Left fibular diaphysis
73	Right proximal tibial epiphysis
74	Right third metacarpal
75	Right fifth metacarpal
77	Proximal hand phalanx
78	Right fourth metacarpal
79	Left third metacarpal
80	Right scaphoid
81	Right mandibular ramus; proximal hand phalanx
82	Left scapula
83	Left rib
84	Fragment of left proximal humeral epiphysis
86	Left rib
87	Lateral diaphysis of right clavicle
88	Left clavicle
89	Fourth cervical vertebra
90	Right rib
92	Rib fragment
93	Proximal hand phalanx
94	Rib fragment
96	Proximal left fibular diaphysis; left fourth metacarpal; left fifth metacarpal; left second metacarpal; proximal hand phalanx
97	Left patella
98	Right first metacarpal
99	Intermediate hand phalanx
100	Right trapezium
101	Proximal hand phalanx; distal hand phalanx; right distal radial epiphysis; right hamate
103	Left scaphoid; two proximal hand phalanges; three intermediate hand phalanges; right distal ulnar epiphysis
104	Right patella
105	Right capitate
106	Proximal hand phalanx
107	Left capitate
108	Unidentified bone fragment
109	Left distal tibial epiphysis
110	Left navicular; left first cuneiform; left distal fibular epiphysis; left second cuneiform; left fifth metatarsal; left second metatarsal
111	Left fourth metatarsal
112	Left third metatarsal

113	Left first metatarsal
114	Distal epiphyses of second and third metatarsals; two proximal foot phalanges; one distal foot phalanx; four proximal epiphyses of proximal foot phalanges
115	Third lumbar vertebra
116	Right proximal epiphysis of the first metacarpal; intermediate hand phalanx; distal hand phalanx
117	Six thoracic vertebral fragments; coracoid process; right lunate; right maxillary second pre-molar; right second rib; left distal radial diaphysis; three left ribs; one proximal first hand phalanx; one intermediate hand phalanx; distal hand phalanx
118	Sixth cervical vertebra
119	Fifth cervical vertebra
120	Right rib
120/121	First cervical vertebra; third cervical vertebra; first thoracic vertebra; second thoracic vertebra
122	Second cervical vertebra
123	Medial diaphysis of right clavicle; left and right first rib; left second rib; seventh cervical vertebra; one thoracic vertebra; three rib fragments; one intermediate hand phalanx; right maxillary first incisor
125	Left maxillary canine; left mandibular first incisor; left mandibular third molar; right mandibular second molar; four fragments of mandible; left coracoid process
127	Greater trochanter of the right femur
128	Right first metatarsal; proximal epiphysis of right first metatarsal; proximal epiphysis of the proximal first foot phalanx; distal first foot phalanx; two proximal foot phalanges; distal epiphysis of third right metatarsal
129	Right fifth metatarsal
C.0X	Left maxilla; four fragments of left parietal; three fragments of right parietal; left mandibular first incisor; left temporal; right zygomatic; right temporal; occipital condyles; four occipital fragments; greater wing of sphenoid left and right; left and right nasal bones; 16 cranial fragments
1A/107/11	Left and right frontal bone
C.4	One fragment of right temporal; 105 cranial fragments; left maxillary second incisor; left zygomatic; one unsided internal nasal conchae
C.15	Sphenoid and right maxilla
C.20	Right lunate; fragment of vertebral body; left distal radial epiphysis; left trapezoid; apophyseal facet of unnumbered vertebra; distal metacarpal epiphysis; nine epiphyses of hand phalanges; left hamate; one intermediate hand phalanx; three distal hand phalanges; proximal epiphysis of left first metatarsal; two proximal foot phalanges; third left cuneiform; two intermediate foot phalanges; two distal foot phalanges; one distal metatarsal epiphysis; three proximal foot epiphyses; one proximal epiphysis of proximal foot phalanx; one proximal epiphysis of intermediate foot phalanx; 6 thoracic vertebrae; coracoid process; right calcaneus; right mandibular canine; first right maxillary incisor; left mandibular condyle; rib fragment
C.22	Five intermediate foot phalanges; two proximal epiphyses of intermediate foot phalanges; two proximal epiphyses of proximal foot phalanges