Archaeological excavations at Killuragh Cave, Co. Limerick

Archaeological excavations at Killuragh Cave, Co. Limerick: a persistent place in the landscape from the Early Mesolithic to the Late Bronze Age

Peter Woodman,[1] Marion Dowd,[2*] Linda Fibiger,[3] Ruth F. Carden[4] and Jane O'Shaughnessy[5]

[1]Department of Archaeology, University College Cork, Ireland.
[2]Centre for Environmental Research Innovation and Sustainability, School of Science, Institute of Technology Sligo, Ireland.
*Corresponding author: dowd.marion@itsligo.ie.
[3]School of History, Classics and Archaeology, University of Edinburgh, Scotland.
[4]Adjunct Research Fellow, School of Archaeology, University College Dublin, Ireland.
[5]National Monuments Service, Dublin, Ireland.

Archaeological excavations at Killuragh Cave, Co. Limerick, in 1993 and 1996 followed from the discovery of prehistoric material in the 1990s by the landowner, Mr Benny O'Neill. Though a small and relatively inconspicuous site, Killuragh Cave has a long history of animal and human usage, potentially stretching back 11,000 years and continuing intermittently until the nineteenth century. The assemblage of 10,615 animal bones, 229 human bones and 209 artefacts of Mesolithic, Neolithic, Bronze Age, post-medieval and modern date indicate that this was a persistent place in the landscape. The prehistoric material largely suggests that the cave was associated with ritual and funerary activities, hinting that it may have been remembered and its significance transmitted from generation to generation over several millennia.

INTRODUCTION

Killuragh Cave, Co. Limerick, is a small, inconspicuous cave on the banks of the Mulkear River. It was only recognised as an archaeological site in the early 1990s when prehistoric artefacts were discovered by the landowner, the late Benny O'Neill. This subsequently led to two archaeological excavations, in 1993 and 1996, with the continued recovery of archaeological material by Mr O'Neill in between. This paper seeks to document the site, to explain the history of discoveries and excavations, to describe the artefacts, human bones and faunal remains recovered, and to discuss the nature and periods of activities represented. Regrettably, records pertaining to the non-archaeological discoveries, as well as those related to the two archaeological excavations, are not ideal and at times are lacking in contextual and stratigraphic information. Despite these issues, there can be little doubt that Killuragh Cave was a significant and potent place in the prehistoric landscape that attracted human activities, primarily of a ritual nature, from the Early Mesolithic through to the Late Bronze Age. The cave appears to have been largely forgotten or ignored in the historic period, although some post-medieval and modern pottery was found in the vicinity.

SITE LOCATION

Killuragh Cave (ITM 578201 649544; RMP LI015-069——) is located in Killuragh townland, 3km south-east of the village of Cappamore, in the north-eastern part of County Limerick (Fig. 1). It lies on the north-eastern edge of a flat limestone reef that is part of a complex Carboniferous series (Strogen 1988). This reef, approximately 400m by 100m, is *c.* 10m higher than the surrounding floodplain and its summit lies just above 60m ASL. The escarpment in which the cave entrance is located faces onto the floodplain of the Mulkear River, a tributary of the River Shannon, located just over 100m to the east. Archaeological excavations in the 1990s concentrated on the central cave (Figs 2 and 3) of at least three caves situated along a 30m stretch of the escarpment (K3 and K2 in Thomas 1995), as well as on the broad flat terrace in front of the entrance. A second cave (K1) is located over 20m to the south, while the third site (K4) lies 8m to the north. It is likely that further cave passages and chambers exist within the reef and that the excavated cave is part of a much more complex system.

CAVE MORPHOLOGY

Killuragh Cave consists of two entrance fissures that terminate in a small chamber (Figs 4 and 5). Entrance

Fig. 1—Location of Killuragh Cave (© Ordnance Survey Ireland/Government of Ireland; Copyright Permit No. MP 004317).

Passage 1 is the larger and more southerly passage and slopes downwards from the terrace at an angle of *c.* 45 degrees. It measures 0.4–0.5m in width and extends for a distance of *c.* 3.2m until it is *c.* 1.8m below the external ground surface, at which point it meets the Main Chamber. Conversations with Mr O'Neill suggest that, prior to any investigations, the upper level of Entrance Passage 1 was filled with stones, loose soil and silt deposits and that there was a concentration or mound of soil at the junction between Entrance Passage 1 and the Main Chamber. From the opening of Entrance Passage 1, the ground gradually slopes down to the Mulkear River (Fig. 6). Entrance Passage 2 lies immediately north of Entrance Passage 1 but at a lower level. It runs horizontally for *c.* 3m before also terminating in the Main Chamber. The Main Chamber is small, measuring a maximum of 1.7m by 1.5m, and, following the 1996 excavation, it was just 1m in height. Prior to investigations, the upper level of the Main Chamber was largely filled with an accumulated series of relatively loose soil and silt deposits, as well as loose stone and large slabs, particularly at the junction with Entrance Passage 1. Passage A (0.5–0.7m high and 0.3–1m wide) runs southwards from the Main Chamber and continues for several metres before becoming too narrow to allow for further investigation. Passage B is

Fig. 2—Killuragh Cave: the openings into Entrance Passage 1 (left) and Entrance Passage 2 (right) from terrace (Sam Moore).

much narrower (0.5m high by 0.4m wide) and extends west from the Main Chamber, continuing for several metres before also becoming too constricted for exploration.

THE FIRST INVESTIGATIONS

Killuragh Cave does not feature in any documentary sources and is not annotated or marked on any historic or Ordnance Survey maps (Fig. 7). It appears to have been relatively unknown in recent centuries, although a local story from the 1960s claimed that a manor house had formerly existed on the site of the current farm buildings. The gamekeeper was said to have put ferrets into Killuragh Cave and the adjacent caves and they would allegedly emerge in the cellars of the manor house two days later (Thomas 1995, 73).

Killuragh Cave was first investigated by the landowner, Benny O'Neill, in the 1950s, when he discovered what appeared to have been a late nineteenth-century glass bottle. In early 1992 he revisited the cave and recovered a three-pronged iron fork, possibly a fishing or agricultural implement of relatively recent origin. With the aim of ascertaining

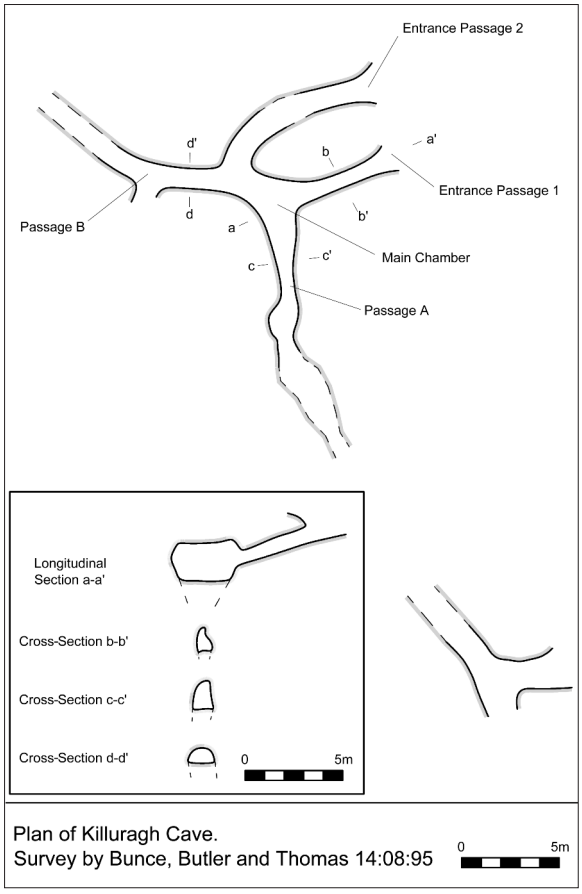

Fig. 3—Plan of Killuragh Cave in 1995 (after Thomas 1995).

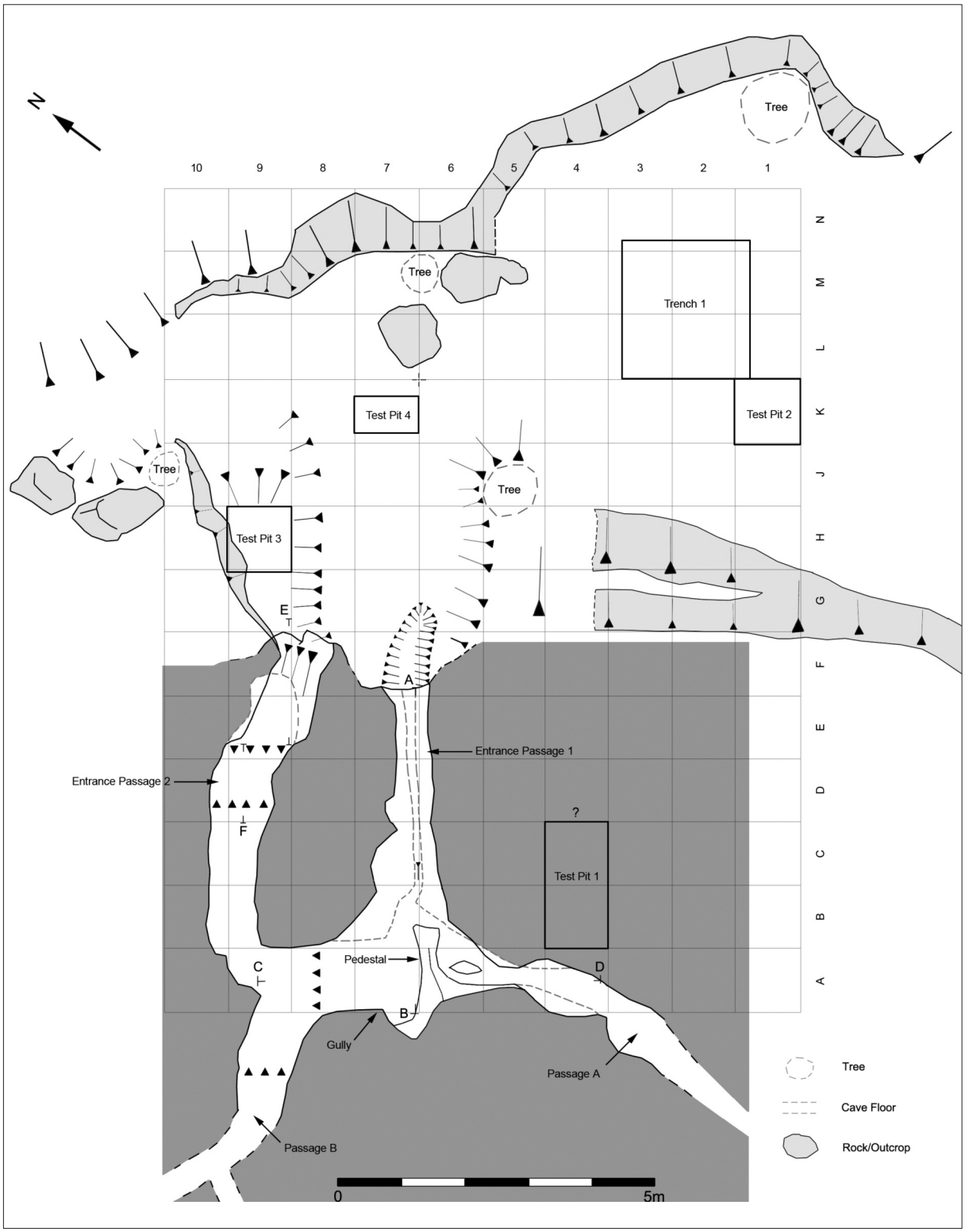

Fig. 4—Plan of Killuragh Cave and terrace, illustrating the 1996 grid system and the locations of the 1996 excavation trenches and test pits (Sam Moore, Thorsten Kahlert and Hugh Kavanagh).

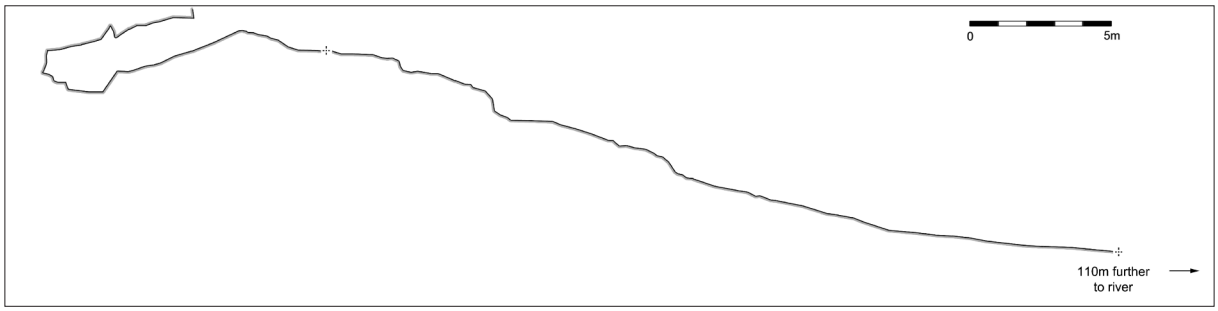

Fig. 6—Profile of Entrance Passage 1 and the terrace outside, with the ground sloping down to the Mulkear River floodplain (Sam Moore and Thorsten Kahlert).

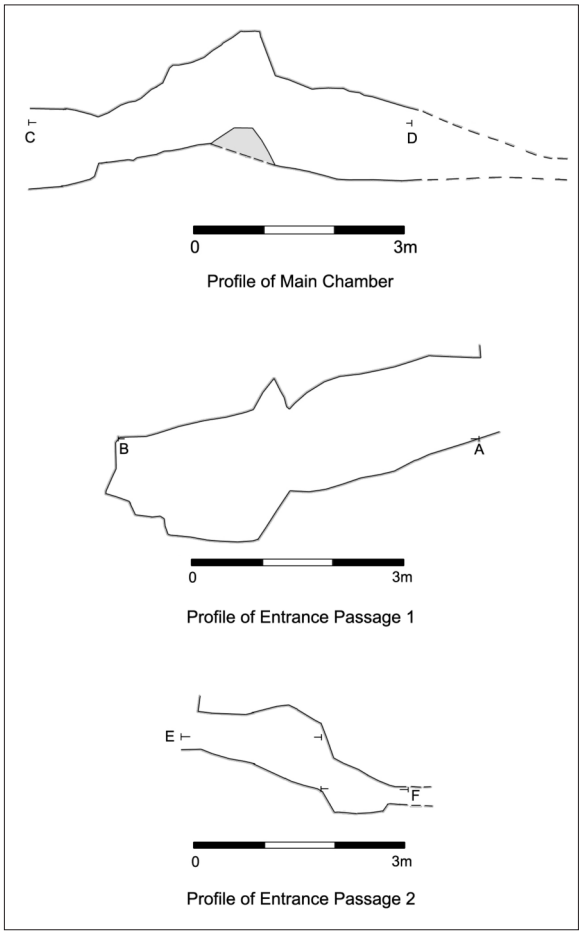

Fig. 5—Longitudinal profiles of the Main Chamber, Entrance Passage 1 and Entrance Passage 2 following the 1996 excavation (Sam Moore and Thorsten Kahlert).

the extent of the cave system, he removed quantities of loose stone and soil from the cave. The sediments contained numerous fragments of animal bones, including frog and rabbit.

In the summer of 1992, during further explorations in the cave, Mr O'Neill recovered human and animal bones, a portion of a ground stone axe (Fig. 8) and a Neolithic flint hollow scraper (Fig. 9.1). He brought these archaeological discoveries to the attention of the National Museum of Ireland (NMI), which was the first time that Killuragh Cave was recognised as an archaeological site. The bones and axe came from at least 'two feet' beneath the surface of deposits in the Main Chamber. Much of the bone appears to have been concentrated at the junction of Entrance Passage 1 and the Main Chamber (probably Sq. B6 and B7 in Fig. 4). A 'layer of blackened stones' was dug out of this area, and pieces of unworked chert and a sherd of Bronze Age pottery were retrieved (Cleary 1992). A small but significant quantity of charcoal was also recovered from the chamber; some pieces were up to 30mm in length, while others were embedded in irregular lumps of baked clay. Mr O'Neill noted that there seemed to be traces of a fire or burning in the deposits he had removed: some of the human and animal bones were black in colour, initially suggesting burning. On analysis, however, both the osteoarchaeologist (LF) and the faunal analyst (RFC) felt that this discolouration was not associated with burning but was due to a chemical or pedogenic interaction between the bones and the cave deposits.

THE 1993 ARCHAEOLOGICAL EXCAVATION (DIRECTOR: J. O'SHAUGHNESSY; LICENCE: 93E0175)

Following visits to Killuragh Cave by members of the Archaeological Services Unit (ASU) of University College Cork (UCC) in 1992, the ASU undertook a three-week archaeological excavation in November 1993 under the direction of one of the authors (JO'S). The excavation was limited in extent owing to budgetary constraints but involved the removal of most of the deposits that remained in the Main Chamber, centring on Sq. A7. O'Shaughnessy recorded that very little undisturbed stratigraphy survived, but the following sequence of deposits was noted:

- Layer of loose soil (0.1–0.2m thick), including small stones and recent debris introduced from outside.

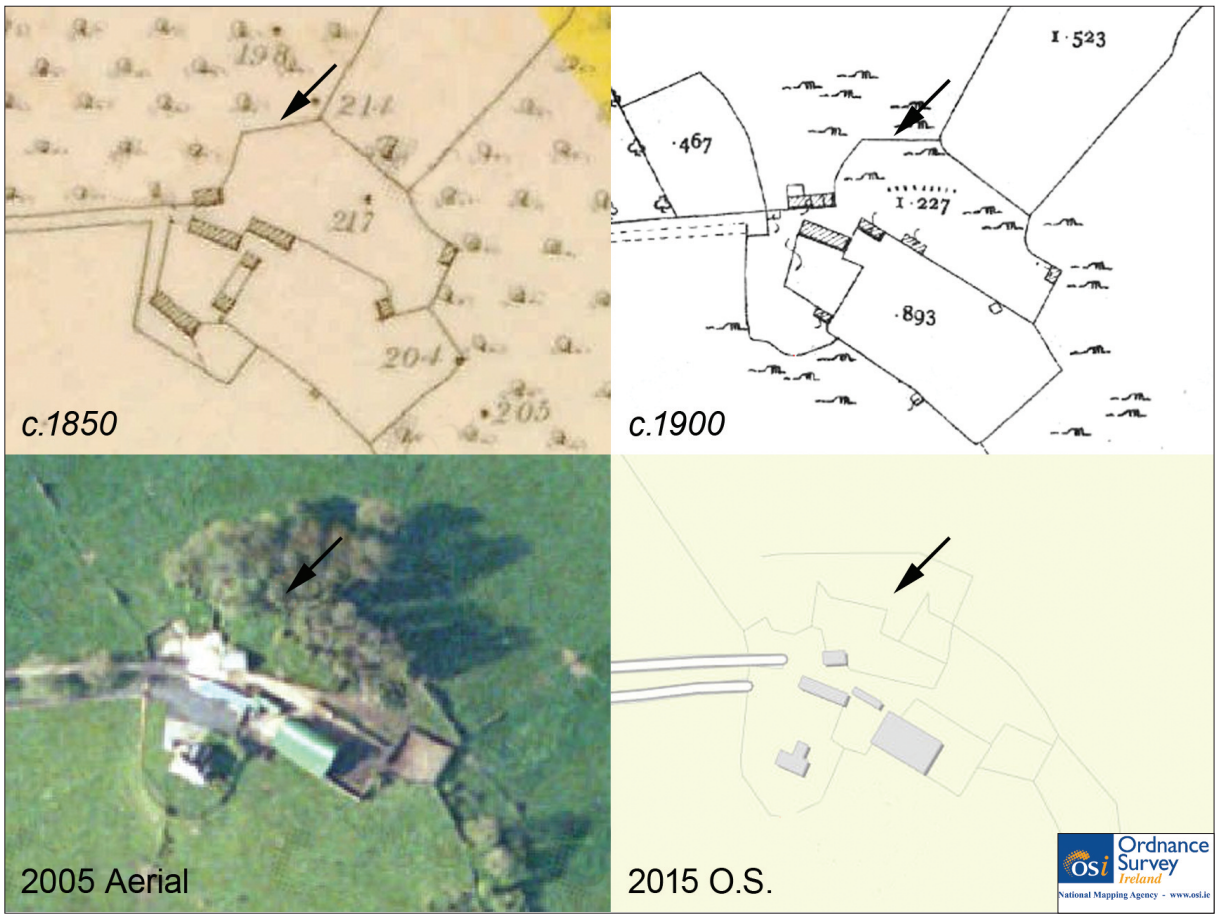

Fig. 7—The location of Killuragh Cave between c. 1850 and 2015 relative to associated farm buildings (© Ordnance Survey Ireland/Government of Ireland; Copyright Permit No. MP 004317).

Fig. 8—Two faces of the ground stone axe fragment of possible Mesolithic date (Hugh Kavanagh).

Fig. 9—Neolithic flint hollow scrapers (1–2) and distal end of large flint flake of probable Late Mesolithic date (3) (Hugh Kavanagh).

Fig. 10—Flint microliths and probable microlith fragments recovered prior to the 1996 excavations, all probably Earlier Mesolithic in date (Hugh Kavanagh).

- Layer of grey-brown silt (up to 1m thick) with moderate inclusions of small and medium-sized stones, animal bones and occasional charcoal. The upper layer was compacted and mixed with debris from Mr O'Neill's investigations. There was evidence of animal burrowing activities and disturbance. It seems to be the same layer that contained much of the archaeological assemblage recovered by Mr O'Neill in 1992, but the layer of blackened stones previously noted by Mr O'Neill was not encountered.
- Layer of apparently sterile orange silt and sand.
- Stiff orange clay that formed the floor of the cave.

The 1993 excavation in the Main Chamber led to the recovery of further human and animal bones, as well as a weathered and patinated flint microlith (Fig. 10.1). A series of radiocarbon determinations on human bones returned dates spanning the Early Mesolithic (at least one adult), Late Mesolithic (adolescent or young adult), Early Neolithic (at least one adult), Middle Neolithic (one adult) and Early Bronze Age (infant) (Table 1). As part of the Irish Quaternary Fauna Project, a sample of a fragmentary large limb bone, then presumed to be of cattle, was radiocarbon-dated, returning a determination in the latter part of the Late Glacial Interstadial (Table 1), suggesting that this was in fact a fragment of a giant deer (*Megaloceros giganteus*) bone and not a cattle bone (Woodman *et al.* 1997).

Four soil samples from the 1993 excavation, all taken at different depths in a brown silty clay in the Main Chamber, were examined by the ASU (Hannon and Tierney 1993–4). The uppermost sample, Sample 1, was the richest organically and produced modern rodent-type animal bone, five land snails, root fragments, frequent charcoal, modern weed seeds (primarily blackberry) and charred plant remains. The latter included one possible barley grain, one possible oat grain, one oat/rye grain fragment, and one each of the weed types *Stellaria*-type (chickweed), *Chenopodium*-type (fat hen) and *Polygonum*-type (dock). The cereal grains were poorly preserved but the weed seeds were intact. Sample 2 produced some modern animal bone, again of rodent-type size, as well as charcoal fragments, one charred rye grain and one possible charred oat grain. Sample 3 contained small animal bones and a few charcoal fragments but no charred plant remains. The lowermost sample, Sample 4, produced one land snail, occasional animal bone and one charred weed seed (*Chenopodium*-type) (Hannon and Tierney 1993–4).

What the range of dates illustrated, particularly considering that the material derived principally from the Main Chamber, was the multi-period nature of Killuragh Cave. Despite its small size and inconspicuous entrance openings, it had witnessed significant activities spanning almost the entirety of Irish prehistory. It was also apparent from the 1993 excavation that there was little reliable stratigraphic integrity within the site, and that both cultural and natural formation processes had led to complex and highly disturbed stratigraphy. While some of the material from the Main Chamber likely attests to human activities inside the cave, it is probable that a significant quantity of artefacts, human bones and faunal remains originated from activities outside the cave. This is based on the small size of the cave, but primarily on the weathering noted on many of the lithics. For instance, the microlith (Fig. 10.1) from the Main Chamber was quite weathered, suggesting that it had been exposed to the elements for a time outside the cave. The suggestion is that material may have been deposited outside the opening of Entrance Passage 1, and was later washed or carried into the chamber by non-anthropogenic agencies.

INVESTIGATION OF THE SPOIL HEAP IN 1994 BY BENNY O'NEILL

The sediments removed from the cave by Mr O'Neill in 1992, and by the archaeological team in 1993, were left as a spoil heap on the terrace outside the cave. As was usual for that time, no extensive sieving programme had been undertaken by the ASU. In 1994 Mr O'Neill began to examine the spoil heap carefully and recovered archaeological artefacts, including a Bronze Age pottery sherd. In August of that year further Bronze Age pottery and a flint blade (Fig. 10.3) were recovered by Mr O'Neill and Raghnall Ó Floinn of the NMI. Several weeks later, Mr O'Neill retrieved further Bronze Age pottery, a Neolithic flint hollow scraper (Fig. 9.2) and the distal tip of a large flint blade or flake (Fig. 9.3). The spoil heap was transferred to an adjacent farmyard, where he proceeded to examine the material with meticulous care and retrieved an assemblage of seven Early Mesolithic flint microliths (Figs 10.4–10.10), as well as quantities of Bronze Age pottery. As a result, wet sieving of the remaining spoil, which had by now become intermixed with modern farm debris, was undertaken in November 1994 by Matthew Kelleher (UCC), employing a 3mm-mesh sieve. Further bone, a flint microlith and undiagnostic iron objects of uncertain age and function were recovered. The small fragments of metal were likely to be modern items dispersed across the area in very recent times in association with the adjacent farm.

THE 1996 ARCHAEOLOGICAL EXCAVATION (DIRECTOR: P. WOODMAN; LICENCE: 93E0175 EXT.)

A second campaign of archaeological excavations took place over two weeks in September 1996 (Fig. 11). This was conducted on behalf of the NMI and what is now the National Monuments Service (NMS), and was directed by one of the authors (PW). The purpose of this excavation was to establish whether other activities contemporaneous with the artefacts already recovered could be identified, and whether there was any evidence that archaeological material had washed into the cave system from the terrace outside. A rigorous programme of wet sieving, using 3mm sieves, was undertaken for all deposits excavated from within the cave, and to a limited extent for deposits excavated outside the cave.

One trench and four test pits were opened outside the cave, and remaining deposits in Entrance Passages 1 and 2 and in the Main Chamber were excavated. The grid system employed is illustrated in Fig. 4. The single-context method was used, with the same stratigraphic layer, if spread over several grids, receiving multiple context numbers to allow for a spatial analysis of the distribution of bones and artefacts throughout the cave system.

Trench 1 (Sq. L2, L3, M2, M3; C.1, C.5, C.7, C.12, C.14, C.39–C.41)
This measured 2m by 2m and was opened on the terrace to the east of Entrance Passage 1. The uppermost stratum produced no traces of activity. In places, below a thin layer of dark soil (C.5), was a layer of shattered limestone fragments (C.12) up to 0.6m thick. This rested on bedrock. The strata in Trench 1 were disturbed and mixed, producing material that was mostly modern but also possibly elements that were older in date. The largest concentration of post-eighteenth-century ceramics, some 43 sherds, came from this trench, as well as large quantities of modern fauna, notably frog and rabbit.

Test Pit 1 (Sq. B4, C4; C.85, C.86)
This pit measured 2m by 1m and was opened on the flat terrace above Entrance Passage 1. Now, more than two decades after the excavation, there is some uncertainty as to its exact location. A thin soil layer produced two small flint flakes intermixed with post-medieval/modern glass and ceramics. In April 1997 Mr O'Neill found a small chert convex end scraper (Fig. 12) in disturbed topsoil near Test Pit 1.

Test Pit 2 (Sq. K1; C.37, C.38)
This measured 1m by 1m and was opened to the south of Trench 1. It produced post-medieval/modern ceramics and glass from the topsoil (C.37).

Fig. 11—The landowners together with the 1996 excavation team. Back row (L–R): Mr Benny O'Neill, Joan Rockley, Margaret McCarthy, Denise Maher. Front row (L–R): Miriam Carroll, Mrs Sheila O'Neill, Marion Dowd, Peter Woodman (Marion Dowd).

Fig. 12—Two views of a chert convex end scraper of Neolithic or Early Bronze Age date (Hugh Kavanagh).

Test Pit 3 (Sq. H9; C.49–C.56, C.88, C.89)
Test Pit 3 measured 1m by 1m and was opened outside Entrance Passage 2 in an area where the ground sloped away quite rapidly. C.50 appeared to have accumulated as a consequence of the 1993 excavations and produced a sherd of Bronze Age pottery and a small flint flake. Underlying this was C.51, a stony stratum that contained fragments of iron, a red deer antler and, near its surface, a human bone. C.53 was the basal deposit, a compact orange clay that appeared to be similar to underlying archaeological layers elsewhere on the terrace outside the cave and which was noted beneath

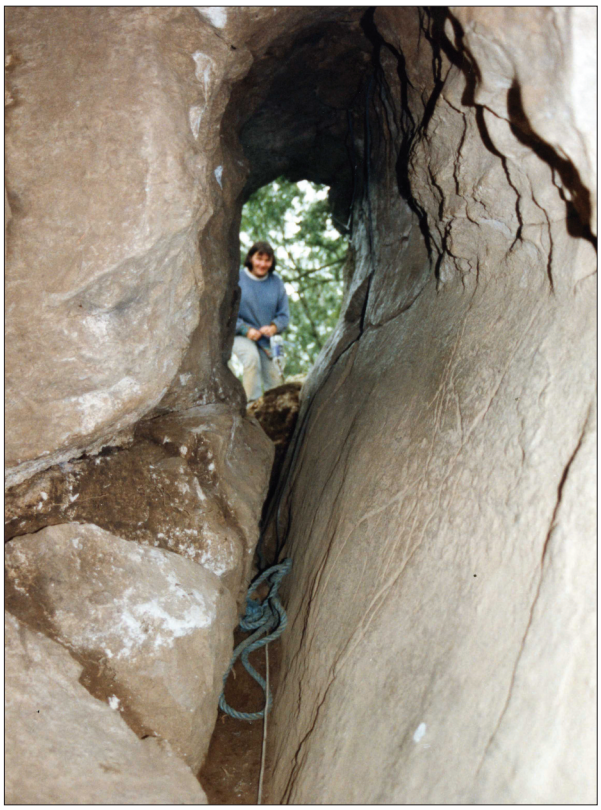

Fig. 13—Post-excavation view of Entrance Passage 1 in 1996, from the Main Chamber looking out towards entrance (Marion Dowd).

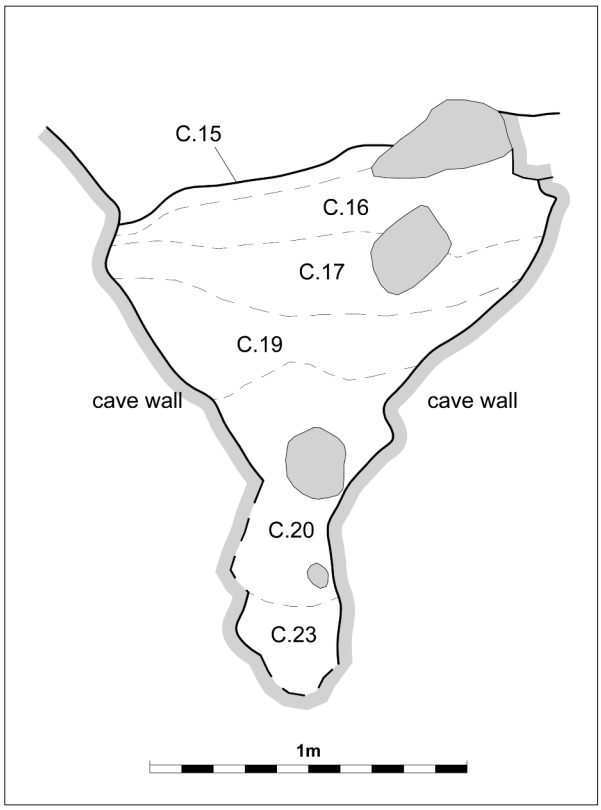

Fig. 14—Cross-section of fissure at the mouth of Entrance Passage 1, Sq. F7.

the archaeological deposits in the Main Chamber. This orange clay may have been created at an early date, such as during the Last Glacial Maximum, and as such predates archaeological activities at the site. It seems probable that much of the material found in Test Pit 3 was residual debris from earlier explorations of the cave. Significant quantities of quite recent ceramics were recovered, as well as large quantities of faunal remains, most notably frog.

Test Pit 4 (Sq. K7; C.87, C.91)
This measured 1m by 1m and was opened *c.* 3m in front of the openings of Entrance Passages 1 and 2. It produced post-medieval/modern pottery.

Entrance Passage 1
Entrance Passage 1 was originally thought to have been cleared of any deposits during early investigations. In 1996, however, a narrow fissure in the bedrock was noted running along the base of the passage (Figs 4 and 13). Inside, this basal fissure measured at most 0.2m in width and was up to 0.4m deep, with distinct stratigraphic sequences surviving (Fig. 14). The contextual data per grid were: Sq. B6/B7, C.76–C.77; Sq. C7, C.57–C.61; Sq. D7, C.62–C.66; Sq. E7, C.67–C.71. Along the length of the passage, upper (Level 1), middle (Level 2) and base (Level 3) strata were recorded. Some slight disturbance to the strata was evident, as bones of relatively 'modern' species, notably rabbit and frog, were occasionally discovered in deeper strata. Generally, however, these 'modern' species were confined to the upper stratum (Level 1) in the fissure, the upper and middle stratum in Sq. F7 at the entrance opening, and the upper stratum in Sq. E7 immediately inside the entrance. Generally, the dog and pig bones were confined to the middle and base strata (Levels 2 and 3). A quantity of small fragments of charcoal was recovered from the fissure. In contrast, a much larger number of pieces of cinder-like material and possibly coal (approx. 280g) were found throughout the length of the fissure from Sq. C6/C7 through to Sq. F6/F7. While burnt material was recovered from Entrance Passage 1 and the Main Chamber, there was no obvious evidence that any fires had been lit within the cave. Modern ceramics were found mostly near the surface. Prehistoric artefacts included a flint blade (Fig. 15.1) from Layer 2 in Sq. C (C.60) and a flint microlith (Fig. 15.2) from Layer 2 in Sq. E (C.69). The faunal assemblage from Entrance Passage 1, excluding the mouth of this passage (Sq. F7), was dominated by rabbit, followed by smaller quantities

Fig. 15—Flint blade (1) and flint microliths (2–3) recovered during the 1996 excavations (Hugh Kavanagh).

of dog, pig, hare and cattle.

On the terrace immediately outside the opening of Entrance Passage 1 (Sq. F7), the excavation trench was enlarged to investigate an area measuring 1m by 1m (C.42–C.48, C.72–C.74). Here, where the basal fissure was slightly broader, considerable numbers of dog bones occurred, almost filling the limestone crevice. Almost the entire assemblage of dog bones from this location showed evidence of having been burnt or altered through exposure to heat. A dog mandible from this location returned a date from the earlier part of the Neolithic (3889–3641 cal. BC) (Table 1). Sq. F7 also produced small quantities of cattle, pig and hare bones, although disturbance is evident in the presence of rabbit. A broken portion of a small flint flake came from C.74 in this grid. Several human teeth were recovered from Sq. F7, including an adult molar from C.73, which returned a Late Mesolithic date of 4704–4458 cal. BC, while a cat humerus from the same stratum and grid returned an early medieval result (Table 1). The scapula of a human infant of around one year of age was also recovered from Sq. F6/F7 (Level 2/3 interface) and was dated to the Early Bronze Age. The quantity of archaeological material and the spread of dates from the opening of Entrance Passage 1 (Sq. F7) reveal that this spot was seemingly a focus for activities from the Mesolithic through to the Bronze Age.

Entrance Passage 2

Excavations in Entrance Passage 2 consisted of the removal of what appeared to be recent deposits (C.15, C.16, C.17, C.19, C.20, C.23, C.83, C.84, C.90) from the outermost 3m of the fissure (Fig. 4). Deposits here, which were often less than 0.1m thick, lay on top of what appears to have been an archaeologically sterile orange clay. The majority of the animal bones from Entrance Passage 2 were from rabbit, followed by cattle, hare, pig and dog in much smaller quantities.

Main Chamber

The 1996 excavations of the Main Chamber were principally confined to Sq. A7 and Sq. A8, at the point where Entrance Passage 1 met the Main Chamber. It was first necessary to remove *ex situ* residual material (C.10, C.11) from earlier explorations of the cave. It soon became apparent that these previous investigations had not completely cleared out the Main Chamber and that *in situ* deposits remained in Sq. A7 and Sq. A8. This was the area where a 'mound' of material was noted by Mr O'Neill prior to archaeological investigations. On excavation it became clear that this layer contained significant quantities of animal bone. The material extended to the west towards the end of Entrance Passage 2. Within Sq. A7 there was a low but significant ridge of stiff orange clay that came to be known as the 'pedestal' (Fig. 4).

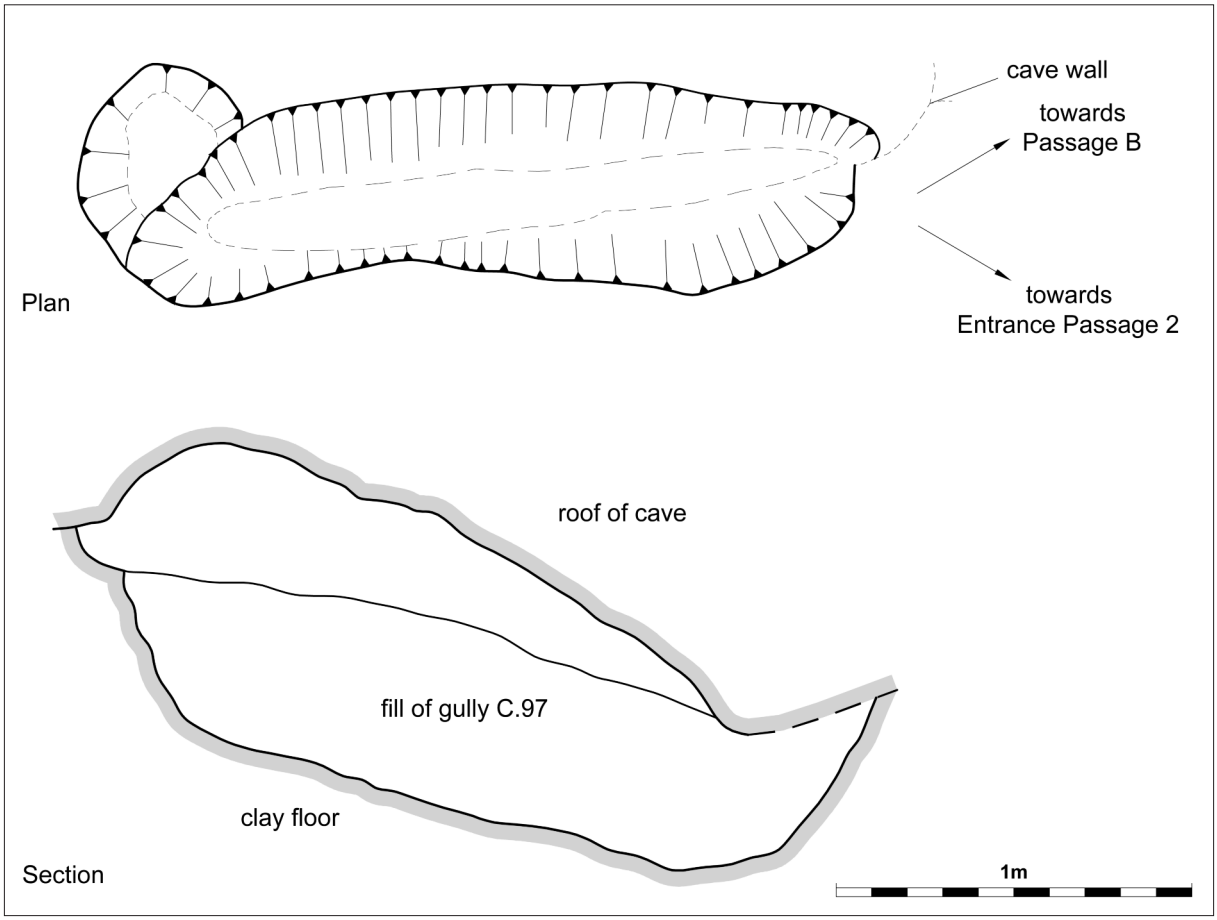

Fig. 16—Plan and section of gully cut (C.30) and gully fill (C.97) in the Main Chamber (Sq. A7).

West of Sq. A8, there was a small alcove in the cave wall at the junction of the Main Chamber and Passage B, called the 'addit'. This alcove was little more than 0.5m long and penetrated 0.2m into the cave wall; it contained deposits that resembled those from the Main Chamber (C.10a, C.18a, C.21). A large concentration of bones, including horse, dog and pig, were recovered from a brown soil that formed the upper level in this alcove. A dog mandible, a pig mandible and a cattle scapula from the alcove were radiocarbon-dated to the Bronze Age: 2568–2290 cal. BC, 1682–1451 cal. BC and 1496–1304 cal. BC respectively (Table 1). Adjacent to the Main Chamber, where the orange clay still survived, a giant deer phalanx was recovered.

A large, conspicuous slab of rock lay against the south-western wall of the Main Chamber in Sq. A7 and may originally have been used to block the end of Entrance Passage 1, effectively closing off the Main Chamber. When the slab was moved in 1996, a pit was exposed (cut C.28, fill C.27). This in turn appears to have truncated an elongated shallow gully that ran along the back wall of the Main Chamber for nearly 1.25m (cut C.98) and was filled with grey silt (C.97) (Fig. 16). Animal and human bones were recovered from the gully, but the material was evidently disturbed: an Earlier Mesolithic microlith was found overlying a layer (C.29) that produced a human mandible dated to the Early Bronze Age (2344–2036 cal. BC) and a possible sheep bone dated to the Middle Bronze Age (1376–1142 cal. BC). In turn, C.29 lay above C.97, which produced a horse sacrum of Middle Bronze Age date (1402–1127 cal. BC) and a pine marten femur of Late Bronze Age date (912–811 cal. BC) (Table 1).

Overall, pig, hare and cattle were the dominant faunal species recovered from the Main Chamber during the 1996 investigations, with much smaller quantities of dog and rabbit. Also recovered were a small number of giant deer bone fragments, as well as over 100 Arctic lemming teeth and bones, suggesting a Late Glacial presence in Killuragh Cave. These were mostly retrieved during sieving of the material from the gully in Sq. A7 (C.97). One reindeer bone was also recovered from the Main Chamber, although it should be noted that other fragments of reindeer were found

outside the cave. In Irish caves, bones of fauna dating from the Late Glacial Interstadial and the Younger Dryas tend not to be found in stiff underlying clay but occur loose, in more superficial deposits. The stiff underlying orange clays at Killuragh are likely to be much older and to date from the last Glacial Maximum (MIS 2) or perhaps even earlier, to MIS 3, i.e. from approximately 50,000 to 16,000 years ago (for a discussion on late Pleistocene chronologies and fauna see Woodman 2014).

Passage B

Reworked deposits, similar to those found in Entrance Passage 2, were encountered at the junction of Passage B and the Main Chamber. Layers of sand and silt were also recorded here, but the deep orange clay was not reached. Bones of a range of species that could be considered quite recent were recovered, such as frog and rabbit.

RADIOCARBON DATES

Given the nature of the Killuragh Cave investigations and excavations, as well as the relative lack of secure stratigraphic sequences from almost all investigated Irish caves (Dowd 2015, chapter 2), it is very difficult to claim integrity for any of the recorded contexts in even the most carefully excavated portions of Killuragh Cave. Thus, while particular artefacts such as the microliths can be ascribed to the Earlier Mesolithic, and the hollow scrapers can be associated with the Neolithic, most of the 10,615 animal bones and 229 human bones cannot be tied to any particular period unless scientifically dated. There are obvious exceptions, however. Bones of giant deer and Arctic lemming can be ascribed to the Late Glacial period, while rabbits and frogs can be associated with the second millennium AD (Woodman *et al.* 1997), although the latter may be associated with an earlier colonisation (no date given: Teacher *et al.* 2009).

Overall, 26 radiocarbon dates were obtained on material from Killuragh Cave: fourteen on human bones and twelve on animal bones (Table 1, see page 30; Fig. 17). With the possible exception of the human remains, however, this is obviously not adequate to elucidate in detail the chronological sequence of events that took place within and adjacent to the cave.

ARTEFACT ASSEMBLAGES

The various investigations and excavations in Killuragh Cave have resulted in the recovery of one chert and sixteen flint lithics of Mesolithic and Neolithic date; a stone axe fragment of possible Mesolithic date; nine sherds of Early Bronze Age pottery; 32 sherds of Late Bronze Age pottery; two fragments representing iron-working of unknown date; and 146 glass, ceramic and clay pipe fragments dating from post-medieval and modern times. The spread of dates represented by the artefact assemblage mirrors the range of dates of the human and animal bones from the site. Each group of material is discussed separately below in approximate chronological order.

Lithics and coarse stone implements (see Woodman 2016a for detail)

The lithic assemblage from Killuragh Cave is likely to be principally of Earlier Mesolithic date, but the fragment of a large blade-like flake, the hollow scrapers (Fig. 9) and the chert convex end scraper (Fig. 12) belong to later periods. Although many of the lithics were recovered from inside the cave, this does not mean that they had originally been deposited there. The varied condition and weathering of the pieces suggest that some may have been exposed outside for a length of time before being redeposited in the cave.

The most notable element of the Killuragh Cave lithic assemblage is the group of ten microliths and microlith fragments. The majority of these were recovered by Mr O'Neill during investigations of the 1993 spoil heap and therefore their original context is uncertain, although they are likely to derive from the Main Chamber. Two small blade fragments (Figs 10.2, 10.9) are also possibly microlith fragments. Of the eight complete or near-complete microliths, at least six could be classified as simple oblique forms (Figs 10.5, 10.6, 10.7, 10.10, 15.2, 15.3), often with retouch on a limited portion of a lateral edge that extends obliquely across the bladelet. Two microliths were simple retouched blades (Figs 10.1, 10.8). They tend to be small and/or quite slender. Only one (Fig. 10.4) could possibly be a portion of a scalene triangle or a rod. Based on the careful platform edge preparation evident on the blades, they may belong to the earliest phases of the Irish Mesolithic.

Examination of many of the deposits, as well as wet sieving, did not reveal any fine debitage or evidence of on-site knapping. If there had been an Earlier Mesolithic habitation site at the cave or in its immediate vicinity, one might have expected manufacturing debris such as cores, core pre-forms and by-products, as well as cortical flakes or fine debitage. No such evidence was encountered, however. It is probable that the Killuragh Cave microliths derive from a small number of composite tools, with a potential comparable example being Tullywiggan, Co. Tyrone (Woodman 1978, 256–7). Given the diversity in the shape of the oblique forms from Killuragh, with

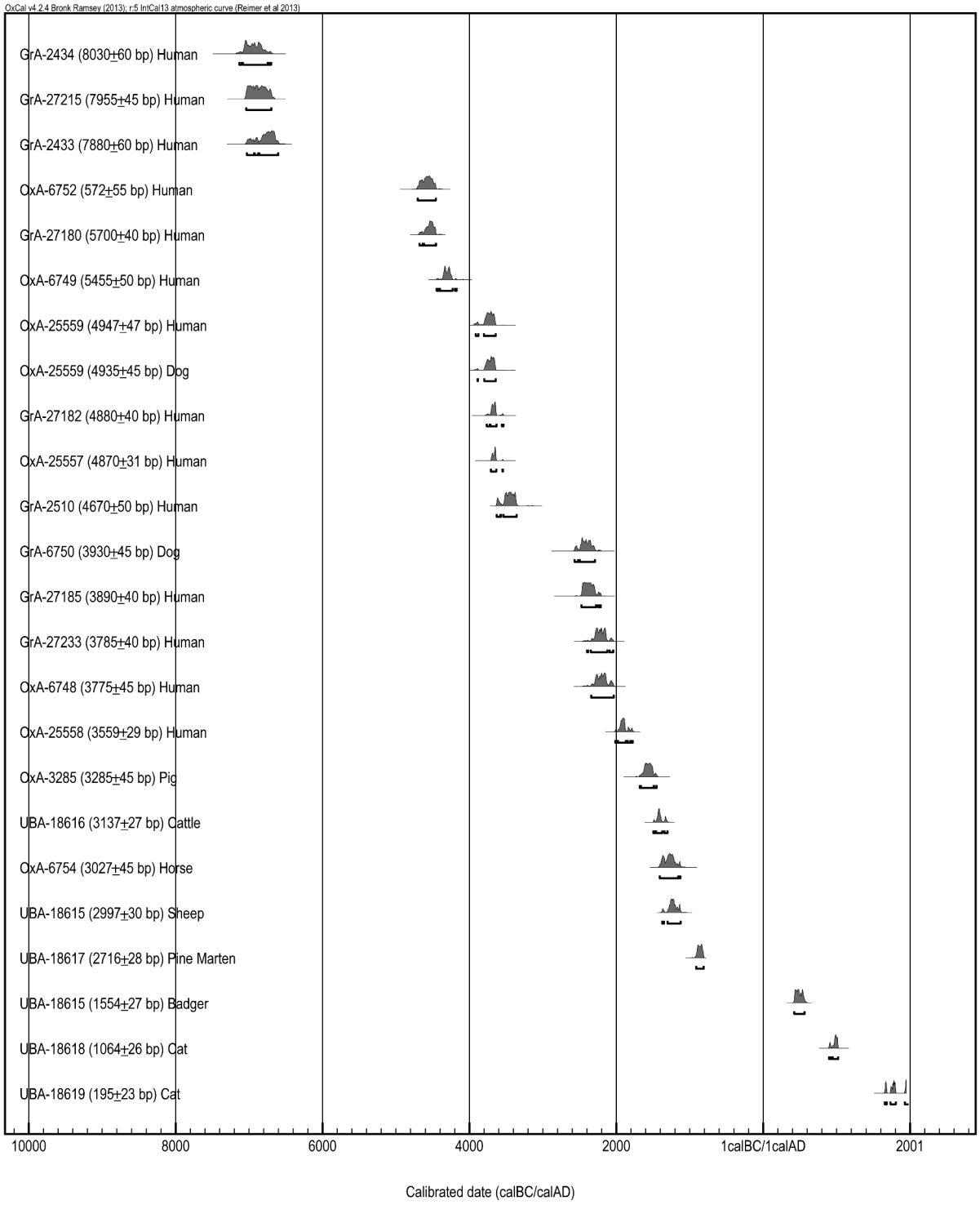

Fig. 17—Plot of the radiocarbon dates on human and animal bones from Killuragh Cave.

Fig. 18—Four sherds of an Early Bronze Age vase urn, vessel 2 (Tony Geoghegan).

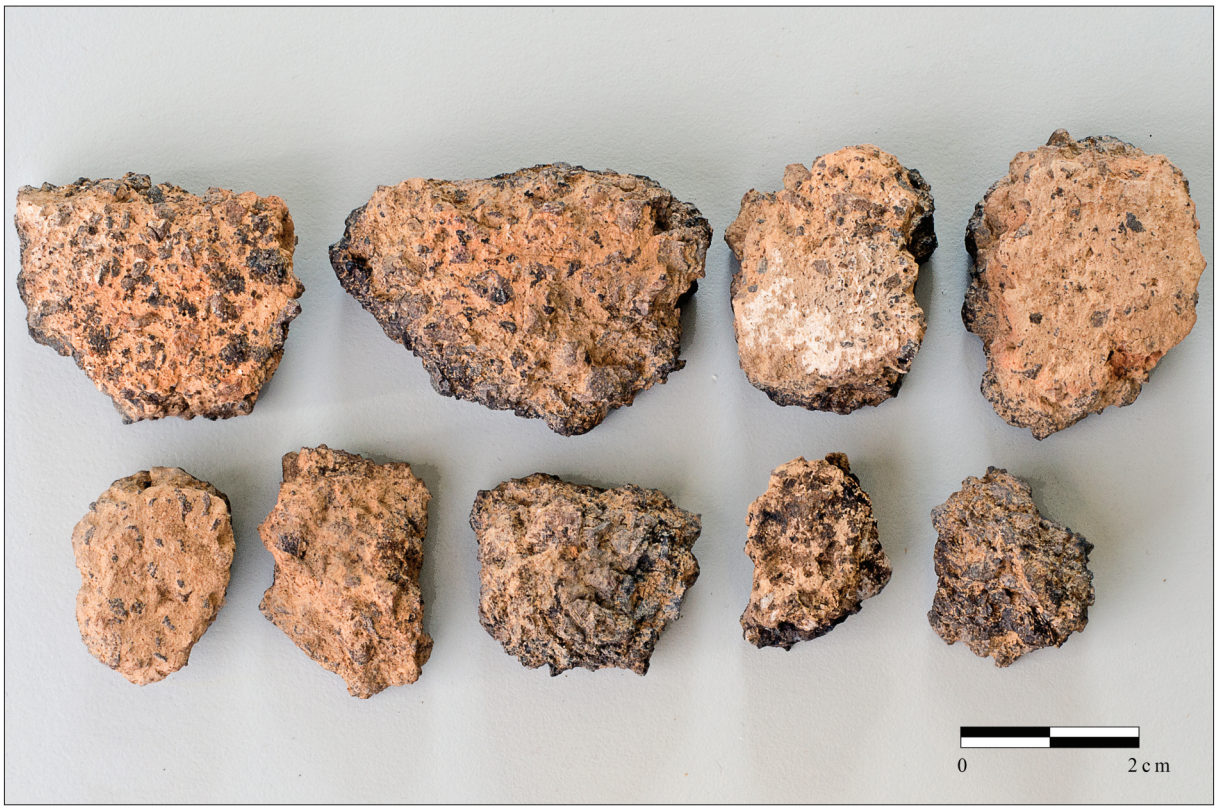

Fig. 19—Nine sherds of Late Bronze Age pottery, vessel 6 (Tony Geoghegan).

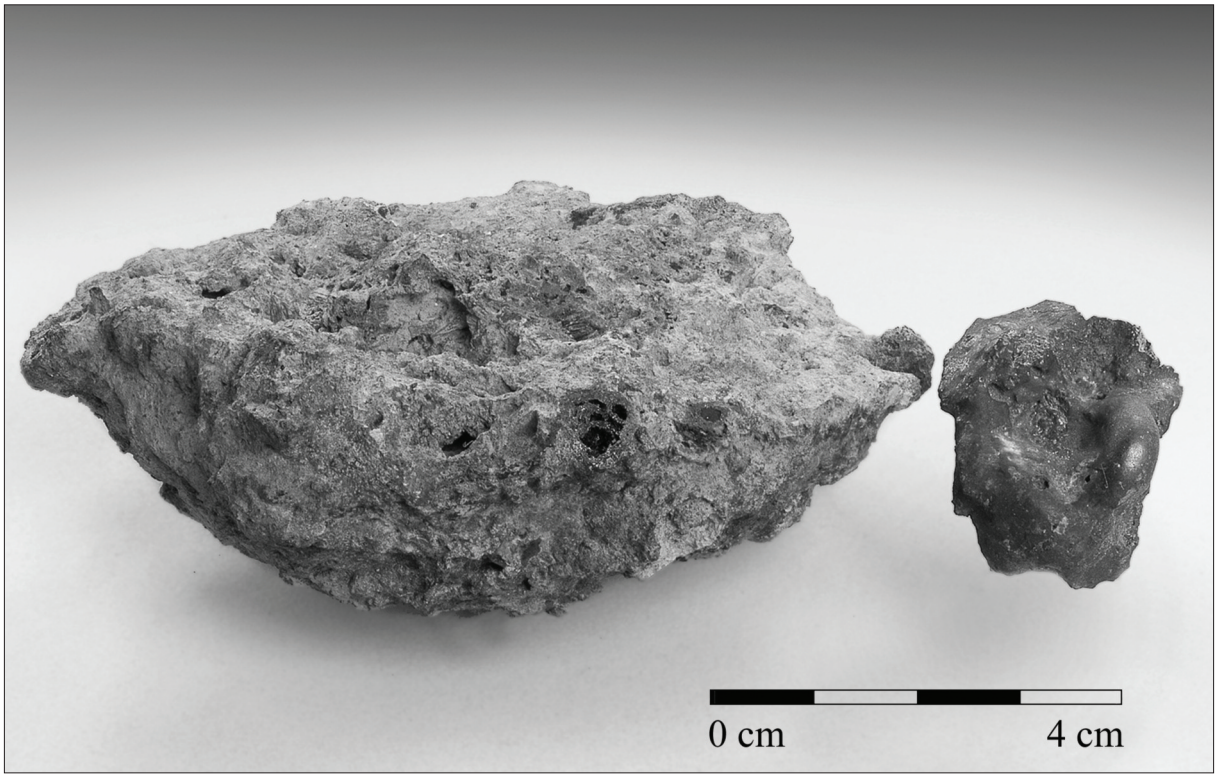

Fig. 20—Hearth cake associated with iron-smithing and a piece of slag (Tony Geoghegan).

notably more squat and elongated forms, it is highly unlikely that they all come from a single composite artefact. At Mount Sandel Upper it was noted that microliths recovered from one layer in a small pit often looked very similar, and in each case the group of microliths may have come from a single composite tool (Woodman 1985, 47–9). Simple oblique forms of microliths often only exist in twos or threes on projectile heads, however. No needle points were noted in the Killuragh Cave assemblage, but with the exception of Lough Boora (Ryan 1980), needle points have rarely been found outside the north-east of Ireland. Similarly, at Kilcummer, Co. Cork, only scalene triangles and small backed rods were found (Woodman 1989; Anderson 1993).

It is impossible to attribute a period to the possible ground stone axe fragment, although it is probably of Mesolithic age (Fig. 8). It has been fractured longitudinally and much of the original surface is missing. The vicinity of what would have been the original cutting edge retains a damaged original surface. The large flint flake fragment (Fig. 9.3) is likely to be Later Mesolithic and is possibly the distal end of a butt-trimmed form. A large, rectangular, square-sectioned coarse-stone hammer was found on the terrace, over 18m from the cave entrance. Numerous narrow, deep pock-marks are visible on one face, with a scatter of other less obvious ones on other faces. The broader end shows signs of intense bruising and, although most of the surfaces are quite smooth, the face that retains most of the pock-marks is almost polished. The date of this artefact is unknown.

Later periods of activity at Killuragh Cave are represented by a smaller number of lithics. The hollow scrapers (Figs 9.1, 9.2) are especially good examples of this artefact type and are of Neolithic date, although it seems likely that they do not occur during the earliest phases of the Irish Neolithic (Woodman 1992). These are usually seen as a much more northern phenomenon, rarely occurring in the southern part of Ireland, but examples have been found at Kilgreany Cave, Co. Waterford (Movius 1935). Although they appear to be very simple objects, hollow scrapers usually require access to good-quality flint, as well as a very deliberate process of manufacture (Woodman *et al.* 2006, 163–6). One example (Fig. 9.1) retains fresh cortex, suggesting that it did not originate from a nearby source of flint and may have been brought to Killuragh from a considerable distance. The chert convex end scraper may have a Neolithic or Bronze Age date.

Bronze Age pottery (see Roche 2016 for detail)
Forty-one sherds of Bronze Age pottery and two lumps of fired clay were recovered from the terrace outside

Fig. 21—Selection of eighteenth- and nineteenth-century pottery sherds from Test Pit 3 (Tony Geoghegan).

the cave and from sieving of the 1992–3 spoil heap. There were three Early Bronze Age vase urns, identified by nine sherds, and three Late Bronze Age vessels represented by 32 sherds (Roche 2016). The Early Bronze Age vase urn sherds were fragmentary but the fabric, rim forms, presence of cordons and incised decoration were consistent with vase urns throughout the country (Fig. 18). The vessels were coil-built with medium- to thick-walled gritty fabric, and varied in colour from orange to grey-brown. Carbonised residue and fire-blackening were present on the three vessels. Faint evidence for decoration survived in sherds from each vessel. The fabric of the three Late Bronze Age vessels was generally hard and coarse. The exterior surfaces were weathered and abraded and inclusions protruded (Fig. 19), although one vessel had been smoothed. Carbonised residue was present on both surfaces of the three vessels. The colour varied from brown to black to orange (Roche 2016).

Iron-working debris

A quite dense smithing hearth cake associated with iron-smithing and a small 'drippy' piece of slag associated with either iron-smithing or smelting (Fig. 20) were recovered from the cave (Angela Wallace, pers. comm.). Also recovered was a quantity of baked clay and charred organic material or cinder that had been subjected to high temperatures in a hearth, as well as whitish oxidised stone material. The date of this material is unknown.

Post-medieval pottery and glass

A total of 145 sherds of post-medieval glass and ceramics and one fragment of clay pipe were recovered and were catalogued by Clare McCutcheon (Fig. 21). The assemblage dates mainly from the eighteenth and nineteenth centuries and includes window glass, bottle glass, stoneware and pearlware ceramics. The brown transfer-printed plate provides good dating evidence, as colours other than blue were introduced from 1829–30; some of the glass fragments represented eighteenth- or nineteenth-century wine bottles (Clare McCutcheon, pers. comm.). The majority of this material was found relatively separate from the prehistoric artefacts and human bones. In areas where prehistoric archaeology was frequent, post-medieval and modern ceramics and glass were relatively rare: e.g. ten sherds came from Sq. F7 at the opening to Entrance Passage 1, and a further sixteen sherds were recovered scattered throughout the length of this passage. Twenty-one fragments of modern ceramics and glass came from Entrance Passage 2, where no prehistoric archaeology was encountered, and from the test trenches on the platform outside the cave, as follows: Test Pit 1 (32 sherds); Test Pit 2 (ten sherds); Test Pit 3 (39 sherds); Trench 1 (fifteen sherds).

HUMAN SKELETAL REMAINS

The human skeletal remains comprised 229 human bones and bone fragments. Initial analysis of the material was carried out by Catryn Power in the 1990s, but the subsequent series of radiocarbon dates, ranging from the Early Mesolithic to the Bronze Age (Table 1; Meiklejohn and Woodman 2012), led to a reanalysis of the assemblage by one of the authors (LF). Osteological analysis was based on standards outlined in O'Sullivan *et al.* 2002 and in Brickley and McKinley 2004.

Zonation

Human skeletal assemblages from caves are complex, taphonomically challenging, chronologically diverse and often incomplete, requiring different analytical approaches than individual burials. As the assemblage from Killuragh Cave consisted mostly of disarticulated and partially fragmented remains, a specialised 'zonation' recording system was applied, developed by Dobney and Reilly (1988) for faunal remains and subsequently adapted by Knüsel and Outram (2004) for human skeletal material. This recording system was successfully applied during the analysis of 24 skeletal assemblages from caves investigated as part of the Human Remains from Irish Caves Project (Dowd *et al.* 2006; Fibiger 2016) and the analysis of human skeletal remains from Glencurran Cave, Co. Clare (Dowd 2009). Rather than creating lengthy descriptions for a bone or fragment, anatomical elements are divided into numbered zones that are defined by drawings and a written description. Each bone or fragment is recorded by all zones present, even if a particular zone is only partly preserved. Also noted is whether the fragment is from the left or right side.

Osteological analysis

Osteoarchaeological analysis included identifying, measuring, weighing and recording by zone each bone or bone fragment, as well as calculating the minimum number of individuals (MNI) represented by the assemblage. This was followed by identifying different age groups within the assemblage and determining adult sex, where possible. Standard osteological measurements were taken where possible, and pathologies, anomalies and taphonomic changes were recorded where present. The information included, where possible, context and location in the cave, size (in cm), weight (in g) and colour (broad classification into light yellow, darker yellow, brown and 'other'), as well as osteological information, including:

- a broad age category (adult, adolescent, juvenile, infant, indeterminate);
- sex (male, possibly male, female, possibly female or indeterminate for adult remains);
- side of skeleton from which the fragment came (left, right, indeterminate);
- anatomical zones present, degree of epiphyseal fusion;
- taphonomic changes present (broken 'wet', broken 'dry');
- fracture shape/angle/texture;
- presence of animal activity/staining/adhering calcite/surface erosion/cracking or flaking/scorching or burning/cut-marks;
- evidence for trauma, degenerative joint disease or other pathologies and anomalies;
- element-specific measurements;
- any further comments.

While it is clear from the radiocarbon dates that individuals from chronologically diverse periods are represented (Table 1), the mostly disturbed and *ex situ* nature of the remains does not allow for subdividing the assemblage, other than those bones directly dated, into clear chronological groups. The remains therefore had to be analysed as one assemblage.

Number of fragments, weight and size

A total of 229 bones and bone fragments, weighing just over 1.2kg, were analysed. This does not include a number of elements that were sampled for radiocarbon dating prior to this analysis. Fragment size ranged from 1.1cm to 10.3cm in length. The largest proportion of fragments came from the hand, skull and foot respectively. Considering contribution by weight, the spine, foot and arm were best represented.

When comparing Killuragh to the 24 assemblages analysed as part of the Human Remains from Irish Caves Project, only two sites presented with a greater number of fragments. Furthermore, the weight of the Killuragh Cave remains places it in the upper quarter of analysed cave sites (Dowd *et al.* 2006; Fibiger 2016).

Taphonomic changes

Caves are complex depositional environments, often characterised by humid conditions, easy accessibility and diverse uses by both humans and animals. As a result, fragmentation, erosion, staining and adhering calcite deposits tend to characterise skeletal remains from caves (Arias and Ontañón 2012; Mlekuž 2012; Dowd 2015). This was also the case at Killuragh Cave.

Generally, the remains from Killuragh were in good or moderate-to-good condition in terms of surface preservation. All breakages appeared to have occurred sometime after death, i.e. at a point when the collagen content of the bone had already decreased considerably (Knüsel 2005), and breakages do not appear to have been related to any funerary or

depositional practice. One piece of frontal bone presented with a cut-mark, but this also appeared to have occurred sometime after death and deposition, possibly even during excavation, as the colour of the cut was slightly lighter than the surrounding bone. The blackish or grey staining observed on some of the human bones most likely relates to the depositional environment (López-González *et al.* 2006). None of the bones showed unambiguous macroscopic signs of burning. Even if some degree of heating or burning occurred, this may have happened sometime after death and/or been accidental, i.e. during later use of the cave. Only one long bone fragment, probably part of a femur, appeared to be partially burned. No elements showed the fissuring patterns characteristic of sustained burning of fleshed remains (McKinley 2000).

Minimum number of individuals (MNI)

The minimum number of individuals represented by the skeletal remains from Killuragh Cave was initially calculated by assessing the total number of diagnostic zones present, by side, in each age group (adult/older adolescent, juvenile and infant). As even partly preserved zones will be recorded as 'present', this can result in a slightly higher MNI, especially when considering long bone diaphysis fragments with overlapping diagnostic zones. The final MNI calculations therefore relied on the identification of the 44 teeth and tooth roots present, and the number of postcranial zones with preserved joint surfaces, as well as elements that could be placed in non-adult age groups through their size and developmental stage. This combined use of different elements was considered the best way to capture MNI of both adults and non-adults in a a very fragmented and complex assemblage.

From the skeletal material present, the remains of a minimum of six individuals were represented. These included at least three adults, two juveniles and one neonate/young infant aged between birth and three months. See below for aging of skeletons. To this total, an infant/young child, aged around one year, must be added. This individual was represented by a right scapula that was sent for radiocarbon dating prior to the current analysis and was therefore not available for examination. Including this older infant brings the total minimum number of individuals to seven. It should be emphasised that this figure is based solely on osteological evidence and is an absolute minimum. Considering the distribution of radiocarbon dates obtained from the human skeletal remains, this number rises to ten individuals, as some elements that appeared to be from one individual based on morphological age assessment were shown to be from more than one individual, based on dating evidence.

Age assessment

Age assessment for the Killuragh Cave non-adult remains was based on observing size, developmental stage, dental calcification, growth and eruption (Ubelaker 1989; Smith 1991; Scheuer and Black 2000). For the adult remains, complete epiphyseal fusion, dental eruption of the third molar and degenerative changes were assessed (Ubelaker 1989; Buikstra and Ubelaker 1994; Scheuer and Black 2000). As preservation was frequently insufficient, elements could usually only be classified as 'Adult' based on size and robustness. It should be noted that some of the non-articular fragments present could have belonged to either older adolescents or young adults. Without being able to assess stages of epiphyseal fusion, it is sometimes not possible to distinguish between the two age groups. Age categories used during the analysis are Neonate (around the time of birth/≤ 1 month), Infant (< 1 year), Juvenile (1–12 years), Adolescent (13–17 years) and Adult (> 17 years).

The Killuragh assemblage included at least one neonate or young infant, represented by a right clavicle and right ilium, as well as another, slightly older infant aged approximately one year, represented by a right scapula (Table 2). Also present were at least two juveniles aged between eight and twelve years, represented by dental remains, a cranial fragment, vertebrae and a foot bone. Two virtually unworn third molars indicate the presence of at least one late adolescent/young adult, in addition to the remains of at least two adult individuals represented by a range of cranial and postcranial fragments. At least one adult appeared to be an older individual, based on a left maxilla that exhibited ante-mortem loss of the incisors, canine and first premolar, a right first metacarpal with osteoarthritis, and a distal left radius and a number of cervical, thoracic and lumbar vertebrae with degenerative joint changes. See below for details of pathological changes.

Sex assessment

Recognisable differences in size and shape between the sexes are known as sexual dimorphism and reach full expression with the end of puberty, making sex assessment most reliable for adult skeletal remains. Differences are most pronounced in the pelvis owing to the biological requirements of childbirth, followed by the cranium and mandible, and can be observed through a number of morphological features (Herrmann *et al.* 1990; Buikstra and Ubelaker 1994). Unfortunately, none of the cranial, mandibular or pelvic fragments from Killuragh Cave displayed diagnostic features. When visually considering differences within the adult assemblage, individuals of varying size/robustness were noted, indicating the

possibility that both sexes are represented. The only long bone measurement available to potentially quantify existing differences was a left radius of length *c.* 21.5cm. Standards for metric sexing exist but are largely based on anatomical collections and modern reference data (e.g. Mall *et al.* 2001). This is problematic, as these groups are culturally, chronologically and/or geographically far removed from the archaeological material under study and do not present appropriate comparisons. The only larger available datasets for Irish archaeological remains date from the medieval period. At Johnstown, Co. Meath, for example, the average left radius maximum length for females was 22.2cm, with a standard deviation of 1.3cm, while the male average was 24.6cm, also with a standard deviation of 1.3cm. The Killuragh Cave value can therefore be placed comfortably within the female range (19.3–25cm) and lies outside the male range (22.1–26.9cm) (Fibiger 2008). Smaller average bone dimensions in prehistoric Ireland must be considered as a possibility, however, and the Killuragh value should ideally be compared to a large prehistoric dataset from Ireland, which is currently not available.

Pathology

Diagnosis of skeletal pathologies—most of which, except trauma, are the result of chronic conditions—often depends not only on the type of change present but also on the distribution of changes throughout the skeleton. Disarticulated, incomplete and fragmented remains present a problem in this respect and changes observed should always be interpreted with particular caution. As this was a very small sample deriving from different time periods, no further statistical summary or analysis was carried out with regard to pathology frequencies.

Dental disease

The most commonly noted dental condition at Killuragh Cave was calculus, which was present on eight teeth. Calculus is mineralised plaque occurring as small flecks or more substantial lumps on the tooth surface. It builds up when dental hygiene is poor and an individual's diet is high in carbohydrates or sucrose (Roberts and Manchester 1995, 55). Teeth were examined for the presence of calculus and deposits were graded for each tooth as slight, moderate or severe (Brothwell 1981, 55). Levels at Killuragh ranged from slight to moderate.

One partial left maxilla and a partial mandible presented evidence of ante-mortem tooth loss and dental abscesses (Fig. 22). The former can be the end result of tooth decay (caries) or damage of the tooth through infection. Abscesses are caused by bacterial infection and, as the infection progresses, the bacteria

Fig. 22—Left maxilla fragment retrieved during sieving, with abscesses and ante-mortem tooth loss (Linda Fibiger).

produce pus that starts to build up within a chamber in the bone. This eventually results in a sinus or hole in the bone that allows the pus to drain (Roberts and Manchester 1995, 50). One tooth also showed evidence of linear enamel hypoplasia, manifesting as a groove in the enamel surface. These defects are the result of nutritional, pathological or physiological stress in childhood during the time of enamel formation (*ibid.*, 58).

Degenerative joint disease

Degenerative joint disease (DJD) is primarily age-related, the result of wear and tear on the joints throughout an individual's life. At times this can have inflammatory origins, or its onset may be related to trauma or other pathological conditions (Rogers and Waldron 1995). The recording of degenerative joint

Fig. 23—Osteoarthritis of proximal 1st metacarpal—right (Linda Fibiger).

changes on disarticulated and fragmented remains can provide important clues about activity and subjection to mechanical loading of joints. The main diagnostic changes on bone include porosity, a pitted appearance of the joint surface; osteophyte formation, bone growth around the joint margin; and eburnation, polishing of the joint surface owing to bone-to-bone contact (*ibid*., 13). Degenerative changes at Killuragh Cave were recorded on the bodies and articular facets of vertebrae from all spinal regions, the articular facets of a number of ribs, a distal left radius, and a number of metacarpals and hand phalanges (Fig. 23).

Summary of the human remains from Killuragh Cave

The 229 human bone and bone fragments from Killuragh Cave represented an MNI of between seven and ten individuals, which makes the site one of the more sizeable human skeletal assemblages from an Irish cave (Fibiger 2016). All age groups—infant, juvenile and adolescent/adult—and possibly both sexes were represented, which is a reflection of the relatively greater size of the assemblage when compared with other, previously analysed cave assemblages (Dowd 2015; Fibiger 2016). In terms of general health, the pathologies recorded were dental disease and degenerative joint disease, which are common occurrences in most archaeological skeletal assemblages. Neither health status nor the age and sex indicators noted in the assemblage suggest a pattern of selection or avoidance of particular individuals in terms of health and disease, age or gender; nevertheless, it should be borne in mind that the current assemblage spans a period of 5,000 years or more and currently only fourteen human bones have been dated. Any selection patterning practised at one particular time may no longer be visible because of admixture of remains from different periods.

All anatomical regions were represented in the Killuragh assemblage. While the relatively limited space available in the cave makes the deposition of complete adult remains an unlikely prospect, it may still be possible that the remains of infants or very young children were introduced into the cave as complete bodies. There is no indication of scavenger activity, suggesting that potentially complete remains were either protected from animals, although the quantity of faunal remains from the cave makes this less likely, or more probably arrived in the cave already skeletonised as dry bone, which would not be as attractive to scavengers (see Dowd 2015, chapter 4). Any fractures present exhibit dry fracture criteria, indicating that they occurred after substantial loss of collagen and quite some time after death and/or deposition (Knüsel 2005). There is a bias towards hand and foot bones in the number of complete elements and fragments, probably because these are mostly small but compact elements that would not suffer from fragmentation to the same extent as the much larger and more complex long bones. While the number of skull elements appears high, the majority of these consist of teeth, mostly isolated finds but including a small number of mandibular teeth still *in situ* in the jaw. The relative absence of cranial vault fragments is probably a reflection of several taphonomic factors, including the fact that dry, i.e. collagen-depleted, cranial vault bones are weaker and more prone to damage and fracturing, as well as that skulls present attractive 'trophies' for anybody entering the cave between the original time of deposition and the relatively recent archaeological investigations, which mainly encountered disturbed deposits rather than intact archaeological contexts.

Killuragh Cave may have been a place for the secondary deposition of human remains, where care was taken to collect and deposit even small skeletal elements. Alternatively, the cave may have been used for excarnation or exposure of remains (Dowd 2015; Fibiger 2016). No evidence for a deliberate attempt to deflesh the remains, in the form of cut-marks, was noted. Again, it is important to note the wide chronological variation in the assemblage, which may represent a variety of ritual and/or funerary practices that are now difficult to establish or differentiate as a result of the mixing of the remains and the poor stratigraphic information available from the site.

The difficult retrieval history and disturbed nature of the deposits in which the remains were found make it difficult to assess exactly how representative they are of the original depositions in the cave. It is clear from the relatively high MNI, even in this disturbed assemblage, that Killuragh was an important place of funerary and ritual activity from the Mesolithic onwards. Further biomolecular analysis, including additional radiocarbon dates and potential aDNA analysis, may help to illuminate the actors and events at cave sites and to shed more light on whose remains were deposited at Killuragh, and whether the nature of deposition at the site changed over its long history of use.

FAUNAL REMAINS

A total of 10,615 bones and bone fragments comprised the Killuragh Cave skeletal faunal assemblage, which had a total combined weight of 9.3kg and was analysed by R.C. Of the full assemblage, 47% of the bone fragments were lacking any anatomical diagnostic characteristics and were unidentifiable. The remaining fragments derived from bird (eleven genera/species),

amphibian (one genus), fish (one genus) and mammalian (28 genera/species) taxa, along with a further five taxonomic groupings (Table 3). Four possibly worked bone fragments were found in the faunal assemblage (Carden and Woodman, in prep.).

The range of identified taxa is similar to identified modern/recent taxa and Quaternary taxa from Irish limestone caves. However, although giant deer, Arctic lemming and reindeer were recorded, no larger megafauna—e.g. mammoth (*Mammuthus primegenius*) and hyaena (*Crocuta crocuta*), which are species typical of the pre-Late Glacial Maximum (LGM)—were found within the Killuragh assemblage. Interestingly, brown bear (*Ursus arctos*) was also absent, although this species occurs in the majority of the excavated Irish caves ranging in geological age from pre- to post-LGM (Monaghan 2017).

Birds

Certain identified species of birds that were found within the Main Chamber (Entrance Passage 1) do not inhabit such locations for roosting or nesting purposes. These included the greylag goose, ducks and smaller passerine species. These remains may have been brought into the cave by carnivorous predators, including humans, or perhaps were washed in from outside. Greylag geese, while a relatively large goose species at *c.* 3kg, are flightless during parts of the year owing to feather moulting and regrowth and may have been easy prey at that time. Very few bird bones (n = 4), all of which were unidentified to species, were found within Entrance Passage 2, and only 30 in total were found outside the cave, the majority of which were also unidentified fragments. A small number of identified bird bones from raven, starling and chicken/red jungle fowl were found outside the cave.

Amphibians

A single unidentified amphibian (frog/toad) and a further 168 frog bones were found in the Main Chamber; 547 frog bones were found outside the cave, and fourteen came from Entrance Passage 2.

Fish

No fish skeletal remains were found outside the cave and only five unidentified partial bones were found in Entrance Passage 2. A total of 59 fish bone fragments were found in the Main Chamber, including one from the Gadidae family, which includes cod (*Gadus morrhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), etc. Killuragh Cave is near the Mulkear River, a freshwater river and far upstream of the mouth of the Shannon Estuary. The presence of marine fish within the cave is therefore likely to be due to human activities.

Mammals

Arctic lemming, bat species, horse, pine marten, pygmy shrew, red deer, fallow deer and a number of mustelid species were found in the Main Chamber, but not outside the cave or in Entrance Passage 2. Reindeer and cat remains were found both in the Main Chamber and outside the cave. The majority of sheep/goat, cattle and horse remains were found in the Main Chamber; the former two were also found outside the cave and to a much lesser extent in Entrance Passage 2. Two hedgehog bones were found within Entrance Passage 2.

The predominant identified taxa from the Main Chamber and Entrance Passage 1 tended towards pig/wild boar (4.0%), hare (3.9%), wood mouse (3.4%), dog (3.1%) and, to a lesser extent, rabbit (2.7%) and Arctic lemming (1.2%). The relatively high frequency of dog bones derived from at least three individuals and the majority of these were charred and/or subjected to high temperatures, which was unusual within this cave assemblage and thus far not found in any other Irish cave faunal assemblage. The majority of the pig/wild boar skeletal remains derived from juvenile individuals (piglets) but at least one adult was also present. Wood mouse skeletal remains dominate in the Main Chamber rather than outside the cave or within Entrance Passage 2. The Main Chamber skeletal material appears to be a mixture of Late Glacial fauna (e.g. giant deer, reindeer and Arctic lemming) and post-AD 1200 species (e.g. fallow deer and rabbit); and both of these latter species were perhaps washed in or deposited at a later, more recent, date. No fallow deer remains have been found on pre-thirteenth-century sites in Ireland, while giant deer, reindeer and Arctic lemming do not survive beyond the Late Glacial period (Woodman *et al.* 1997; Beglane 2015, 23–37). The natural history of the dog in Ireland is currently unknown.

Condition of the faunal remains

The majority of the assemblage was highly fragmentary; only 9% were complete bones and these were either teeth or smaller cuboid/compact bones such as phalanges or carpals/tarsals and bones of smaller-sized mammals, e.g. wood mouse and hare, while the remainder of the assemblage was represented by fragments of cranial and postcranial skeletal elements. Within Irish cave assemblages the predominance of fragmentary skeletal remains varies. Where whole skeletal elements have been present, they have been biased towards whole teeth and whole smaller compact cuboid bones of the fore and hind limbs. For example, at Ballynamintra Cave, Co. Waterford, only 7.5% of the faunal assemblage consisted of whole, complete bones, whereas at the Edenvale complex, Co. Clare, where some 12,000 bone remains have been examined from four caves, the

relative abundance of whole bones from each cave ranges from 10.6% to just over 60% (Carden, unpublished data).

The faunal remains from Killuragh Cave exhibited various taphonomies, including gnawing/scavenging marks left by carnivores and rodents (2.3% and 0.3% respectively) and bone weathering (0.9%). In comparison, gnawing and scavenging marks occurred at greater frequencies in the faunal assemblages from Ballynamintra Cave (rodents: 1.5%; carnivores: 29%) and the Edenvale complex (rodents: 0.9–8.8%; carnivores: 16–29%) (Carden, unpublished data). Within Killuragh Cave, therefore, either the bone fragments were quickly buried or subjected to speedy depositional processes, or there was a lack of access to the bone material, or no carnivores/rodents were present within the cave. Just 5% of the fragments were porous, generally associated with juvenile bones. Nearly 8% of the fragments exhibited some degree of decalcification, which may be associated with weathering and/or subjection to high temperatures. Almost 25% of the full assemblage exhibited charring and/or had been subjected to high temperatures; the majority of these bones were found in the Main Chamber. Just ten fragments displayed some kind of bone-related pathologies.

Butchery-related marks were rarely observed: only eight fragments from the full assemblage exhibited chop/cut-marks. The infrequent occurrence of bone fragments exhibiting butchery-related marks from Killuragh Cave is notable, given that at Ballynamintra Cave 1.8% of the assemblage exhibited such marks, as did 4.4–16% of the bones from the Edenvale complex (Carden, unpublished data). Perhaps the high proportion of charred/burned bones from Killuragh Cave made the preservation of such marks impossible.

Distribution of the faunal remains

Given the disturbed stratigraphy at Killuragh and the various investigations, it might be thought that the fauna would be so disturbed and mixed that few patterns could be identified. The location of the bones of several species can be used to identify areas where later disturbance or intrusions took place, and in certain cases to identify where some form of prehistoric activity occurred.

Aside from the Late Glacial fauna, the one species mostly recovered *in situ* were the Neolithic dog remains in Entrance Passage 1, especially in Sq. F7 at the mouth of Entrance Passage 1. As indicated, however, by the presence of rabbit and frog, this passage had also been subject to later disturbance. Nevertheless, this concentration of dog bones can be contrasted with the pig, cattle and sheep remains that occurred in the Main Chamber, the 1992–3 spoil heap and the original material collected by Mr O'Neill.

Early medieval dates were also returned for some animal bones, such as a badger metatarsal from the Main Chamber, and a slightly more recent date on a cat humerus from Entrance Passage 1 (Table 1). A comparatively modern cat skull was also recovered (Table 1). While rabbit bones were found in most contexts, which clearly indicates more recent disturbance, 50% came from Entrance Passage 2. The relatively recent usage of Entrance Passage 2 is also indicated by the 871 frog bones, *c.* 60% of which came from Entrance Passage 2 and from the trench and test pits on the terrace.

DISCUSSION AND INTERPRETATION: KILLURAGH CAVE THROUGH TIME

No apparently *in situ* strata or contexts were recorded in Killuragh Cave and extensive disturbance of deposits was apparent throughout the system. An oblique flint microlith (Fig. 15.3) was found in C.27, which overlay deposits that produced two of the Bronze Age radiocarbon dates on a human jaw fragment from C.29 (fill of gully) and a horse bone fragment from C.97 (lower fill of gully) (see Table 1). The artefacts from Killuragh Cave, and probably the majority of the human and animal bones, can be considered *ex situ*, which is also reflected in the varying condition of some items. For instance, the Earlier Mesolithic microlith assemblage included fresh lithics (Figs 10.3, 10.4) as well as weathered and patinated pieces. Similarly, a flint fragment (Fig. 9.3), possibly the tip of a butt-trimmed form, was quite patinated and weathered. This is not to say that all the flint implements lay exposed since deposition. One hollow scraper (Fig. 9.1) displayed a variation in patination that suggests that it was partially buried at an early date. In spite of the disturbed nature of the deposits, the radiocarbon dates (Table 1) suggest that much of the material belongs to a series of specific events (Fig. 17), although not necessarily very precise single events. Conversely, as will be seen below, there also appear to have been quite long periods of time during which no activities took place at or in the cave.

Glacial Interstadial/Younger Dryas

This phase is represented by a single radiocarbon date on a giant deer bone (Table 1) and the presence of over 100 Arctic lemming teeth, which could also date from the Younger Dryas. A small number of undated reindeer bones may also date from the Glacial Interstadial, the Younger Dryas or the pre-Late Glacial Maximum. It is not clear how bones of these species came to be in the cave. While hare also dates from the Late Glacial (Woodman *et al.* 1997) and is represented in the

Killuragh assemblage, this species may be a more recent intrusion.

Mesolithic

The prehistory of Munster from the Neolithic onwards is well known (e.g. O'Brien 2012), and the extent of Bronze Age settlement has been clearly demonstrated by developer-led excavations (e.g. Hanley and Hurley 2013, 61–199; Cleary 2015). Nevertheless, evidence for the Mesolithic, and in certain areas the Earliest Neolithic, is still quite scant. Killuragh Cave therefore presents an important contribution to our knowledge of prehistoric Munster. It is one of a limited number of sites in Limerick and north Cork associated with the Earlier Mesolithic (Woodman 2015, 251–3, fig. 9.10). These include an Early Mesolithic cremation that contained a microlith and a possible microlith fragment at Hermitage on the banks of the River Shannon, Co. Limerick (Collins and Coyne 2003; Collins 2009). Further south, on the Camogue River, during his excavation of a ring-barrow cemetery at Rathjordan, Co. Limerick, Ó Ríordáin (1948) discovered two microliths and blades in what appears to have been a disturbed Earlier Mesolithic site. Finally, a substantial Earlier Mesolithic site producing numerous microliths was discovered at Kilcummer, at the junction of the Awbeg and Blackwater rivers (Woodman 1989; Anderson 1993). All these are focused on rivers, and clearly the proximity of Killuragh Cave to the Mulkear River was significant. Hunter-gatherers may have recognised the cave as a significant point when travelling along the river or on fishing trips. The fish bones recovered from the cave may reflect Mesolithic activities, but these have yet to be radiocarbon-dated.

Apart from microliths, the Earlier Mesolithic phase at Killuragh is represented by two individuals. One is represented by a metacarpal and a vertebra centring in date on approximately 7000 cal. BC. A possible second individual, again represented by a metacarpal, is slightly later in date and with a slightly different $\delta^{13}C$ (7029–6605 cal. BC) (Table 1; Fig. 17). A series of diagnostic microliths and blades would conventionally have been associated with what had been described as the 'Early' Mesolithic. As discussed by Woodman (2012; 2015, chap. 5), however, a case can now be made for there being two phases within an 'Earlier' Mesolithic. The first of these is represented at Mount Sandel, where a distinctive range of microliths, triangles, rods, needle points etc. occur. Then, somewhere around 7000 cal. BC, there was a Creagh phase, when microliths were becoming less common or had ceased to be used. Are the very simple microliths from Killuragh Cave part of this diminution in the use of microliths, and were they associated with the human remains dated to the Earlier Mesolithic? There is no clear evidence that the very simple Killuragh forms are contemporaneous with the earliest Mount Sandel phase of the Mesolithic, i.e. prior to 8500 cal. BC.

As discussed by Woodman (2015, 253, fig. 9.10), in many parts of Munster there is a notable lack of Later Mesolithic material, and often, when it does occur, the period is represented only by individual finds. Of significance is a tanged butt-trimmed form as well as Late Mesolithic cremations from Hermitage (Collins and Coyne 2003; Collins 2009). At Killuragh, at least two individuals from the final stages of the Mesolithic are represented by three radiocarbon dates (Table 1; Fig. 17). This evidence includes a tooth (4708–4458 cal. BC) from the mouth of Entrance Passage 1 (Sq. F7, C.73), and a vertebra (4679–4456 cal. BC) from the Main Chamber. While these two dates are almost identical, a mandible fragment that also came from the Main Chamber (4446–4174 cal. BC) probably came from a different individual. A portion of what may have been a large flint blade or butt-trimmed form potentially dates from this phase of activity, though it is not possible to associate it definitely with the human remains.

The Mesolithic activities at Killuragh Cave, as represented by a series of disarticulated human bones, reflect ritual and/or funerary activities. There are no indications of settlement debris. For instance, there is an almost complete absence of species likely to have been hunted during the Mesolithic and, although the cave is close to the Mulkear River, few fish bones were recovered, and none of these have been radiocarbon-dated. The weathered condition of some of the human bones and lithics, as well as their spatial distribution through the cave, strongly suggests that hunter-gatherers may not have entered the cave but rather placed isolated bones and implements outside the mouth of Entrance Passage 1, after which they were carried into the cave by natural processes, with two examples being a flint blade (Fig. 15.1) and an oblique microlith (Fig. 15.2) in the basal layers of Entrance Passage 1. That the radiocarbon dates intermittently span the Mesolithic period suggests that the cave was a persistent place in the landscape that was visited periodically, each time resulting in the votive deposition of human bones, occasionally accompanied by lithics, including composite tools that included several microliths. What is remarkable is the inconspicuous nature of the cave. It quickly becomes overgrown, and the two entrance passages silt up naturally within a few years. This suggests that the cave was regularly visited and its location remembered from generation to generation. There is no indication that complete bodies were ever deposited at the site and thus Killuragh Cave cannot be considered a burial/interment site as such, but rather a special place

in the landscape that was visited and marked by the deposition of dry disarticulated bones. With less than ten sites known on the island of Ireland to have produced human bones, Killuragh Cave provides tantalising insights into some of the ritual practices of hunter-gatherer communities, the significance of certain natural features and the treatment of the dead. Although limited in number, other Irish caves have produced human bones and artefacts of Mesolithic date, strongly suggesting that, like Britain, further evidence of the elusive funerary and ritual aspect of hunter-gatherer life remains to be discovered in caves (Dowd 2015, chap. 4).

Neolithic

Killuragh Cave seemingly continued to be considered a sacred place in the landscape into the Neolithic. This period is well represented by four radiocarbon dates on human bones and one date on an animal bone. Dates on a human vertebra, radius and cranial fragment centre on the period 3800–3600 cal. BC; these elements may all belong to a single individual (Table 1). The dog mandible recovered from Entrance Passage 1 was of similar date. Another Early Neolithic date on a human metacarpal (3631–3357 cal. BC), although still within the Early Neolithic, is sufficiently different as to indicate a distinct individual. The slightly lower $\delta^{13}C$ also points to this being a second person. No Neolithic pottery was recovered from Killuragh Cave and there are no Neolithic dates from domesticates.

An Early Neolithic presence in south Clare and north Limerick is evident at sites such as Parknabinna court tomb (Schulting *et al*. 2012) and Poulnabrone portal tomb (Lynch 2014), while the human remains from Carrigdirty on the Shannon estuary (O'Sullivan 2001, 73–86; Woodman 2016b, 16–17) are broadly contemporaneous. One might even argue that some of the Neolithic material found by Ó Ríordáin (1948) at Rathjordan could be of similar date to Killuragh. The Early Neolithic human inhumation burials from Annagh Cave (Ó Floinn 2012), situated close to Killuragh Cave, are also relevant. However, the disarticulated and dispersed nature of the Neolithic and Bronze Age human bone from Killuragh Cave is more typical of what is found in other Irish caves; formal burials such as those at Annagh are rare (Dowd 2008; 2015; Fibiger 2016).

An emerging aspect of funerary and ritual cave use in Neolithic Ireland is that many of the same sites had previously been used during the Mesolithic (Dowd 2015, chap. 5), and Killuragh Cave is a prime example. While the possibility cannot be discounted that the site was forgotten and abandoned after the Mesolithic, only to be rediscovered in the Neolithic, it is far more likely that knowledge of this special place persisted and was recognised by early farmers, as it had been by previous generations of hunter-gatherers. The nature of the Neolithic material, namely small quantities of disarticulated human bones and occasional lithics, mirrors the Mesolithic deposits. It is not inconceivable that the type of funerary/ritual activities enacted at this cave followed a broadly similar grammar across several millennia. This potential for continuity challenges the perception that the Mesolithic and Neolithic were two entirely distinct periods, with little 'follow through' from one to the other.

Killuragh Cave contributes to our understanding of Neolithic funerary and ritual practices in a part of the country that is almost totally devoid of megalithic tombs. The Neolithic evidence is not consistent with the so-called 'single burial tradition' (Brindley and Lanting 1989–90), as there is no evidence of formal interment at or in the cave, and it does not bear the hallmarks of excarnation that have been encountered in various other Irish caves (Dowd 2015, chap. 5). It does, however, highlight the varied and complex nature of post-mortem processing of the dead and the distribution of human remains across the landscape. The Neolithic evidence from Killuragh points towards token deposition of small quantities of human bones, on an irregular but repeated basis, at what must have been considered a significant natural place. Sites like this raise several questions. Where are the skeletons from which small numbers of isolated bones were removed? Were the bones deposited at the cave from individuals who were relatively recently deceased or were these 'old' bones? What other places or monuments in the landscape are connected to Killuragh Cave via the dispersal of bones from an individual? What prompted the disposal of these bones, given that the quantities indicate that it was not a frequent rite? The Neolithic evidence suggests that a 'breaking up' of the human skeleton and its subsequent dispersal at a variety of natural places in the landscape may have been more common than is currently appreciated for non-megalithic regions of Ireland. The practice may even have its roots in the Mesolithic.

Late Neolithic/Chalcolithic

The final group of human remains could belong to one or more shorter phases that span the Late Neolithic and possibly extending into the beginning of the Bronze Age. A dog bone (2568–2290 cal. BC) is slightly earlier than the human bones, which derive from four different individuals. The latter include a tibia of a two–three-month-old infant (2474–2211 cal. BC), an adult mandible (2344–2036 cal. BC) and a scapula of a one-year-old child (2397–2043 cal. BC). The date from an adult tibia (2028–1890 cal. BC) is sufficiently later to indicate that it is a different individual from that

represented by the mandible (Fig. 17). The Later Neolithic dates may correspond with the two hollow scrapers.

Bronze Age

The Earlier Bronze Age pottery from Killuragh Cave probably post-dates the human bones. The assemblage of Late Bronze Age pottery cannot, so far, be associated with any other artefacts or with any of the human bones. The dates obtained from four major domesticates (Table 1) all belong to a relatively short period of time, however, between approximately 1600 and 1100 cal. BC, and may overlap with some of the pottery.

A horse sacrum, possible sheep bone, pine marten femur and a human mandible fragment were retrieved from deliberately cut features at the rear of the Main Chamber. The pine marten was selected for dating, as all pine marten bones from the Quaternary Fauna Project had returned Bronze Age dates (Woodman *et al*. 1997), as did the sample from Killuragh Cave (912–811 cal. BC). It appears that, possibly for the first time, prehistoric people squeezed through the narrow Entrance Passage 1 and made their way into the deepest part of the cave. Here they dug a long, linear gully feature and appear to have deliberately placed animal bones in it. A pit was later dug into this gully feature, and was again used for the deliberate deposition of animal bones. No artefacts appear to have been associated with this activity. The pottery also suggests the deliberate deposition of broken sherds and fragmented vessels at the cave. This is consistent with the wider deposition of Bronze Age pottery in Irish caves, where the placement of sherds rather than intact vessels was the norm and seems to represent some form of ritual veneration (Dowd 2009; 2015, chap. 6). It is plausible, therefore, that echoes of the ancestral significance of Killuragh Cave as a potent ritual place in the Mesolithic and Neolithic landscape continued to be recognised throughout the Bronze Age. The Late Bronze Age pottery marks the last identifiable evidence of prehistoric usage of this small, inconspicuous, subterranean space that witnessed sporadic ritual activities over many millennia.

Early medieval, post-medieval and modern

Three bones, one from a badger and two from cats, were chosen to assess the extent of later intrusions into the cave. The badger and one cat returned early medieval dates. There is nothing to suggest that these are anything other than natural occurrences, although the iron-working debris may be contemporaneous and could suggest smithing activities around the cave entrance, or the disposal of such waste into the cave. One of the dates, on a cat bone, is broadly contemporaneous with the eighteenth- and nineteenth-century glass and ceramic finds; these represent the most recent use of Killuragh Cave. The glass and pottery were primarily recovered from the terrace outside and probably represent debris dumped there by inhabitants of the adjacent farmhouse, or may have been present in infill material used to level the ground around the cave.

CONCLUDING COMMENTS

The excavations and investigations at Killuragh Cave have revealed it to be a very rich multi-period site, but the full potential of the recovered material has yet to be realised. The majority of the human and animal bones are of unknown date. A further comprehensive radiocarbon-dating programme is likely to be highly beneficial, particularly in terms of establishing the periods of human activity represented by the butchered and burnt faunal remains. Further radiocarbon dates on bird and fish bones would also be very useful.

One question that has not been fully resolved is how many of the prehistoric artefacts and bones were deliberately deposited within the cave. It seems that some, if not all, of the Mesolithic and Neolithic material may represent deposits of a ritual nature placed outside the mouth of Entrance Passage 1, and were subsequently washed or carried into the cave by natural agency. The Neolithic dog deliberately buried at the opening of Entrance Passage 1 may represent an animal 'guarding' this distinctly liminal threshold. By the Bronze Age, however, cut features and deliberate deposits in the interior indicate that people were intentionally entering the cave, engaging with and creating features in the interior, and depositing ritually significant material in specific places. The Main Chamber was the focus of activities. At this time one could only have entered Killuragh Cave in single file, and it is unlikely that the cramped interior would have held more than three people at any one time. Indeed, it is more likely that the ritually charged activities of the Bronze Age were conducted by one individual, although others may have waited outside. Similar scenarios have been suggested for cave use elsewhere in Ireland at this time, and the constricted and somewhat tortuous journey into the interior of Killuragh Cave is replicated at several other cave sites (Dowd 2016).

Within the last millennium other activities appear to have taken place at or in the immediate vicinity of the cave. Possibly as a consequence of the demolition and repositioning of the farm buildings (Fig. 7), some of the later material may have been inadvertently pushed downslope towards the cave and pushed inside. This could explain the large quantity of relatively

recent post-medieval ceramics from Test Pit 1, which lay closer to the farm buildings than the other test pits and overlooked the terrace. It is also possible that material may have been dumped off the escarpment onto the river floodplain. Generally, when Irish caves were explored in recent centuries they were seen primarily as sources of faunal remains and artefacts, with little attention paid to the exterior areas adjacent to the entrances, and the possibility of activities having taken place there being rarely considered. Thus, while Mr O'Neill's explorations of the cave system brought to light a rich range of archaeological material and fauna, his discoveries have also raised the question of the nature of the activities that took place on the terrace outside the cave.

There is also a question concerning the burnt material and the possibility of burning within the cave. None of the artefacts or human bones shows evidence of contact with fire. In contrast, the burning of so many dog bones, in particular from Sq. F7, may reflect a specific event. Other domesticates, i.e. cattle, sheep and pig, which came predominantly from the Main Chamber and its derivative deposits in the spoil heap, may have derived from a nearby settlement. These species have lower rates of burning, at approximately 15%. In comparison, approximately 25% of the hare bones show signs of burning. One might presume that this happened outside the cave. A major issue is that the residues of fires from historic periods may have been dumped into the cave. It may be significant that over 30% of the cat bones recovered during the excavations show signs of exposure to fire. It is also notable that while some burnt bones were recovered from the trenches outside the cave, there was little evidence of burning on bones from Entrance Passage 2. If metal-working was taking place, as suggested by the furnace bottom, is it likely that the associated debris was dumped into Killuragh Cave rather than the cave being used as part of a smelting/metal-working process?

The Mesolithic, Neolithic and Bronze Age artefacts and faunal remains from Killuragh Cave do not reflect what might be expected from settlement sites from any of these periods. In tandem with this is the intermittent presence of human remains from *c.* 7000 cal. BC to just after 2000 cal. BC, the possibility of a number of composite tools of Earlier Mesolithic date being deliberately deposited at the cave, and the concentration of dog bones at the threshold to Entrance Passage 1. All of this is strongly suggestive of the use of Killuragh Cave for ritual purposes and its perception as a ritual focus in the landscape.

ACKNOWLEDGEMENTS

This paper is dedicated to the memory of Mr Benny O'Neill (1936–98).

We extend our warmest thanks to the family of the late Mr Benny O'Neill, and particularly to Mrs Sheila O'Neill, for their help and hospitality during and since the excavations. We acknowledge here the important contribution that Benny made to Irish archaeology.

We would like to thank the archaeologists who worked on the excavations: Flor Hurley in 1993; Matthew Kelleher in 1994; and Miriam Carroll, Denise (Maher) Sheehan, Margaret McCarthy, Joan Rockley and Majella in 1996. Many thanks to the specialists who conducted analyses of the various aspects of the Killuragh Cave assemblage: Margaret McCarthy, Clare McCutcheon, Catryn Power, Helen Roche and Angela Wallace. Thanks to Lisa Moloney and Rita MhigFhionnghaile for post-excavation work. Our sincere gratitude to Hugh Kavanagh for his time, advice and work on the illustrations. For permission to use their images here, our thanks to Sam Moore, Thorsten Kahlert and Tony Geoghegan. Funding for the excavation and post-excavation work was provided by the National Monuments Service, the National Museum of Ireland, the Heritage Council, the Irish Research Council, the Prehistoric Society and other independent sources. At the NMI, we would like to gratefully acknowledge the generous assistance of Mary Cahill and Raghnall Ó Floinn over many years. At the NMS, our thanks to Pauline Gleeson. The comments and feedback of Kerri Cleary, three anonymous reviewers and the editor have greatly benefited this paper. Over twenty years have passed since the last archaeological excavations at Killuragh Cave; if we have inadvertently omitted anyone from the acknowledgements, we apologise.

Table 1—Radiocarbon dates on human and animal bones from Killuragh Cave.

Species and element	Area, context, year of discovery	$\delta^{13}C$	$\delta^{15}N$	Lab code	Measured radiocarbon years (BP)	Calibrated radiocarbon date (2σ) BC	Period
Giant deer; metacarpal	Main Chamber (1993)	-20.2		OxA-4605	11510±100	11,598–11,194 BC	Late Glacial Maximum
Human; adult 1st metatarsal	Main Chamber (1993)	-20.86		GrA-2434	8030±60	7085–6700 BC	Early Mesolithic
Human; adult cervical vertebra 2 (C2)	(Found by B. O'Neill, 30.11.1995)	-21.13	11.2	GrA-27215	7955±45	7039–6698 BC	Early Mesolithic
Human; adult 1st metatarsal	Main Chamber (1993)	-19.95		GrA-2433	7880±60	7029–6605 BC	Early Mesolithic
Human; adult maxillary molar	Mouth of Entrance Passage 1: Sq. F7, Level 2, C.73 (1996)	-21.3		OxA-6752	5725±55	4704–4458 BC	Late Mesolithic
Human; adolescent/young adult vertebra	Main Chamber: 'below 2nd large stone' (1993)	-21.5	9.52	GrA-27180	5700±40	4679–4456 BC	Late Mesolithic
Human; adult right mandible	Main Chamber	-21.9		OxA-6749	5455±50	4446–4174 BC	Late Mesolithic
Human; adult cranial fragment	Main Chamber: Sq. A7 (1993)	-20.99	9.3	OxA-25559	4947±31	3783–3656 BC	Early Neolithic
Dog; mandible	Mouth of Entrance Passage 1: Sq. F7 (1996)	-20.4		OxA-6751	4935±50	3889–3641 BC	Early Neolithic
Human; adult cervical vertebra 2 (C2)	Main Chamber (1993)	-21.49	9.3	GrA-27182	4880±40	3765–3588 BC	Early Neolithic
Human; adult left radius	Main Chamber (1993)	-21.31	8.9	OxA-25557	4870±32	3707–3544 BC	Early Neolithic
Human; adult 1st metatarsal	Main Chamber (1993)	-22.36		GrA-2510	4670±50	3631–3357 BC	Middle Neolithic
Dog; mandible	Main Chamber: alcove in 'addit' west of Sq. A8 (1996)	-20.9		OxA-6750	3930±45	2568–2290 BC	Early Bronze Age
Human; neonate/young infant (0–3 months old) left tibia	Main Chamber (1993)	-22.88	11.83	GrA-27185	3890±40	2474–2211 BC	Early Bronze Age
Human; infant (*c.* 1 year old) right scapula	Mouth of Entrance Passage 1: Sq. F6/7, Level 2/3 interface (1996)	-23.35	11.78	GrA-27233	3785±40	2397–2043 BC	Early Bronze Age
Human; adult left mandible	Gully in Main Chamber: Sq. A7, C.29 (1996)	-21.1		OxA-6748	3775±45	2344–2036 BC	Early Bronze Age
Human; adult right radius	(Found by B. O'Neill)	-21.08	11.5	OxA-25558	3599±29	2028–1890 BC	Middle Bronze Age
Pig; mandible	Main Chamber: alcove in 'addit' west of Sq. A8 (1996)	-21.6		OxA-6753	3285±45	1682–1451 BC	Middle Bronze Age
Horse; sacrum	Gully in Main Chamber: Sq. A7, C.97 (1996)	-22.8		OxA-6754	3020±45	1402–1127 BC	Middle Bronze Age
Sheep?	Gully in Main Chamber: Sq. A7,C.29 (1996)	-22.48	5.18	UBA-18615	2997±30	1376–1142 BC	Middle Bronze Age
Cattle; scapula	Main Chamber: alcove in 'addit' west of Sq. A8, C.10a (1996)	-22.08	6.13	UBA-18616	3137±27	1496–1304 BC	Middle Bronze Age
Pine marten; femur	Gully in Main Chamber: Sq. A7, C.97 (1996)	-20.4		UBA-18617	2716±28	912–811 BC	Late Bronze Age
Badger; metatarsal	Main Chamber: Sq. B6/B7, C.10	-20.45	7.49	UBA-18614	1554±27	AD 424–564	Early medieval
Cat; humerus	Mouth of Entrance Passage 1: Sq. F7, C.73, Level 2 (1996)	-21.56	9.96	UBA-18618	1064±26	AD 899–1022	Early medieval
Red deer; tibia	Outside cave (found by B. O'Neill)	-22.5		OxA-6111	955±50	AD 992–1189	Early medieval
Cat; skull	Main Chamber? (1993)	-21.83	9.85	UBA-18619	195±23	AD 1656–1930	Post-medieval/modern

Table 2—Highest minimum number of individuals (MNI) for different elements and age groups.

Element	**MNI Late Adolescent/ Adult**	**MNI Adolescent**	**MNI Juvenile**	**MNI Infant**
Maxilla: canine left	3			
Maxilla: 3rd molar right	2			
Mandible: lateral incisor left			2	
Mandible: canine left	2			
Mandible: canine right	2			
Mandible: premolar 2 left	2			
Lateral clavicle right				1 (Young Infant)
1st rib left	2			
Ilium right				1 (Neonate/Young Infant)
Humerus: distal medial half right	2			
Humerus: distal lateral half right	2			
Hand: MC1 left	3			
Hand: MC2 left	3			
Hand: MC3 left	2			
Hand: MC4 left	2			
Hand: MC5 left	2			
Hand: MC1 right	3			
Patella right	2			
Foot: navicular right	2		1	
Foot: navicular left	3			
Foot: MT5 right	2			

Table 3—NISP of faunal remains from Killuragh Cave.

NISP	Trench 1	Test Pit 1	Test Pit 2	Test Pit 3	Test Pit 4	Entrance Passage 1	Entrance Passage 2	Main Chamber	1993 Excavation*	Pre-1996 spoil heaps*	TOTAL
Total fragments	341	48	4	819	381	1937	391	3625	1116	1953	**10615**
Total weight (g)	598.9	50.1	5	350.7	92.3	1182.2	658.2	1393.7	1981.3	2968.8	**9281.1**
Birds											**0**
Raven (*Corvus corax*)	1										**1**
Eurasian jay (*Garrulus glandarius*)						3					**3**
Sedge warbler (*Acrocephalus schoenobaenus*)						3					**3**
Starling (*Sturnus vulgaris*)	2					9				8	**19**
Redstart (*Phoenicurus* sp.)										2	**2**
Snipe (*Gallinago gallinago*)									1		**1**
Gallus sp.									2	5	**7**
Red junglefowl (*Gallus gallus*)	5								10	12	**27**
Widgeon (*Mareca* sp.)										6	**6**
Gadwall (*Anas strepera*)										3	**3**
Greylag goose (*Anser anser*)									13	5	**18**
Bird sp.	13			7	2	14	4	159			**199**
Bats											**0**
Natterer's bat (*Myotis nattereri*)								1			**1**
Lesser horseshoe bat (*Rhinolophus hipposideros*)								1			**1**
Leisler's bat (*Nyctalus leisleri*)								1			**1**
Bat sp.								3			**3**
Fish											**0**
Gadidae sp.										1	**1**
Fish sp.						3	5	59			**67**
Amphibians											**0**
Frog (*Rana* sp.)	27			276	240	146	14	32	57	79	**871**
Toad/frog (*Bufo/Rana*)										1	**1**
Mammals											**0**
Cattle (*Bos taurus*)	13	10	1	12	4	7	5	10	10	26	**98**
Horse (*Equus* sp.)									2	1	**3**
Sheep/goat (*Ovis/Capra*)	2	2	1	4		9	6	10	5	22	**61**
Pig/wild boar (*Sus scrofa*)	26			13	5	48	8	231	65	85	**481**
Giant deer (*Megaloceros giganteus*)								2	2		**4**
Red deer (*Cervus elaphus*)									2	3	**5**
Reindeer (*Rangifer* sp.)	4								1		**5**
Red deer/reindeer (*C. elaphus/Rangifer*)	1										**1**
Fallow deer (*Dama dama*)										1	**1**
Deer sp.								1	1	1	**3**
Hare (*Lepus* sp.)	21			6	1	29	16	242	30	112	**457**
Rabbit (*Oryctolagus cuniculus*)	7			52	4	127	149	10	56	90	**495**
Hare/rabbit (*Lepus/Oryctolagus*)	4				4	1		7	44	39	**99**
Fox (*Vulpes vulpes*)	4			6	1	14	10	42	16	20	**113**
Dog (*Canis lupus familaris*)	4			5	5	227	6	8	28	69	**352**
Canid sp.	2			4		4	1	15			**26**
Cat (*Felis* sp.)	8					6	10	4	28	19	**75**
Stoat (*Mustela erminea*)						1					**1**
Weasel (*Mustela nivalis*)								2	1		**3**
Pine marten (*Martes martes*)						1		6			**7**
Badger (*Meles meles*)	3					1	2	1	2	5	**14**
Carnivore sp.						5		4	1		**10**
Hedgehog (*Erinaceus europaeus*)							2				**2**
Pygmy shrew (*Sorex minutus*)								17			**17**
Arctic lemming (*Dicrostonyx torquatus*)								132			**132**
Rat (*Rattus* sp.)				2	2	1	2	1	1	8	**17**
Wood mouse (*Apodemus sylvaticus*)				2	1	7		345	3	1	**359**
Mouse sp. (*Mus* sp.)						3		11			**14**
Large mammal	73			13		24	29	7	19	5	**170**
Medium/large mammal	4	6		52	7	215	27	176	143	75	**705**
Medium mammal	35		2	3	3	293	2	97	37	9	**481**
Small/medium mammal	1			3	1	45	29	9		2	**90**
Small mammal	5	1				1		60			**67**
NISP	265	19	4	460	280	1247	327	1706	580	715	**5603**
NISP weight (g)	581	42.2	5	300.4	66.4	961.1	625.8	1044	1840.4	1501.2	**6967.3**

*P. Woodman assumed that these remains were from the Main Chamber (Entrance Passage 1) and they were interpreted as such.

REFERENCES

Anderson, E. 1993. The Mesolithic: fishing for answers. In E. Shee-Twohig and M. Ronayne (eds), *Past perceptions: the prehistoric archaeology of south-west Ireland*, 16–24. Cork University Press, Cork.

Arias, P. and Ontañón, R. 2012. La Garma (Spain): long-term human activity in a karst system. In K.A. Bergsvik and R. Skeates (eds), *Caves in context. The cultural significance of caves and rockshelters in Europe*, 101–17. Oxbow Books, Oxford.

Beglane, F. 2015. *Anglo-Norman parks in medieval Ireland*. Four Courts Press, Dublin.

Brickley, M. and McKinley, J.I. 2004. *Guidelines to the standards for recording human remains*. IFA Paper No. 7. BABAO and IFA, Southampton/Reading.

Brindley, A.L. and Lanting, J.N. 1989–90. Radiocarbon dates for Neolithic single burials. *Journal of Irish Archaeology* 5, 1–7.

Brothwell, D. 1981. *Digging up bones*. Cornell University Press, Ithaca.

Buikstra, J.E. and Ubelaker, D.H. 1994. *Standards for data collection from human skeletal remains*. Arkansas Archaeologial Survey, Fayetteville.

Cleary, K. 2015. *Archaeological networks: excavations on six gas pipelines in County Cork*. The Collins Press, Cork.

Cleary, R.M. 1992. Prehistoric burials at Killuragh townland. In *Cappamore—a parish history*, 39–40. Cappamore Historical Society, Cork.

Collins, T. 2009. Hermitage, Ireland: life and death on the western edge of Europe. In S. McCartan, R. Schulting, G. Warren and P. Woodman (eds), *Mesolithic horizons: papers presented at the Seventh International Conference on the Mesolithic in Europe, Belfast 2005*, 876–9. Oxbow Books, Oxford.

Collins, T. and Coyne, F. 2003. Fire and water: early Mesolithic cremations at Castleconnell, Co. Limerick. *Archaeology Ireland* 17 (2), 24–7.

Dobney, K.M. and Reilly, K. 1988. A method for recording archaeological animal bones: the use of diagnostic zones. *Circaea* 5, 79–96.

Dowd, M. 2008. The use of caves for funerary and ritual practices in Neolithic Ireland. *Antiquity* 82, 303–17.

Dowd, M. 2009. Middle and Late Bronze Age ritual at Glencurran Cave, Co. Clare. In N. Finlay, S. McCartan, N. Milner and C. Wickham Jones (eds), *From Bann flakes to Bushmills*, 89–100. Prehistoric Society Research Papers 1. Oxbow Books, Oxford.

Dowd, M. 2015. *The archaeology of caves in Ireland*. Oxbow Books, Oxford.

Dowd, M. 2016. In search of darkness: cave use in Late Bronze Age Ireland. In M. Dowd and R. Hensey (eds), *The archaeology of darkness*, 63–74. Oxbow Books, Oxford.

Dowd, M., Fibiger, L. and Lynch, L.G. 2006. The Human Remains from Irish Caves project. *Archaeology Ireland* 20 (3), 16–19.

Fibiger, L. 2008. Johnstown 1. Johnstown. Human skeletal remains. In N. Carlin, F. Walsh and L. Clarke (eds), *The archaeology of life and death in the Boyne floodplain*, CD Appendix. National Roads Authority, Dublin.

Fibiger, L. 2016. Osteoarchaeological analysis of human skeletal remains from 23 Irish caves. In M. Dowd (ed.), *Underground archaeology: studies on human bones and artefacts from Ireland's caves*, 3–37. Oxbow Books, Oxford.

Hanley, K. and Hurley, M.F. 2013. *Generations: the archaeology of five national road schemes in County Cork*. NRA Scheme Monographs 13. National Roads Authority, Dublin.

Hannon, M. and Tierney, J. 1993–4. Soil sample analysis from Killuragh Cave, Co. Limerick. Unpublished report, Archaeological Services Unit, University College Cork.

Herrmann, B., Grupe, G., Hummel, S., Piepenbrink, H. and Schutkowski, H. 1990. *Prähistorische anthropologie. Leitfaden der feld- und labormethoden*. Springer, Heidelberg.

Knüsel, C.J. 2005. The physical evidence of warfare—subtle stigmata? In M.P. Pearson and I.J. Thorpe (eds), *Warfare, violence and slavery in prehistory*, 49–65. British Archaeological Reports, International Series 1374. Archaeopress, Oxford.

Knüsel, C.J. and Outram, A.K. 2004. Fragmentation: the zonation method applied to fragmented human remains from archaeological and forensic contexts. *Environmental Archaeology* 9, 85–7.

López-González, F., Grandal-d'Anglade, A. and Vidal-Romaní, J.R. 2006. Deciphering bone depositional sequences in caves through the study of manganese coatings. *Journal of Archaeological Science* 33, 707–17.

Lynch, A. 2014. *Poulnabrone: an Early Neolithic portal tomb in Ireland*. Archaeological Monograph Series 9. The Stationery Office, Dublin.

McKinley, J. 2000. The analysis of cremated bone. In M. Cox and S. Mays (eds), *Human osteology in archaeology and forensic science*, 403–12. Greenwich Medical Media, London.

Mall, G., Hubig, M., Büttner, A., Kuznik, J., Penning, R. and Geaw, M. 2001. Sex determination and estimation of stature from the long bones of the arm. *Forensic Science International* 117, 23–30.

Meiklejohn, C. and Woodman, P.C. 2012. Radiocarbon dating of Mesolithic human remains in Ireland. *Mesolithic Miscellany* 22 (1), 22–41.

Mlekuž, D. 2012. Notes from the underground: caves and people in the Mesolithic and Neolithic karst. In K.A. Bergsvik and R. Skeates (eds), *Caves in context. The cultural significance of caves and rockshelters in Europe*, 199–211. Oxbow Books, Oxford.

Monaghan, N.T. 2017. Irish Quaternary vertebrates. In P. Coxon, S. McCarron and F. Mitchell (eds), *Advances in Irish Quaternary studies*, 255–92. Atlantis Press, Paris.

Movius, H.L. 1935. Kilgreany Cave, Co. Waterford. *Journal of the Royal Society of Antiquaries of Ireland* 65, 254–96.

O'Brien, W. 2012. *Iverni: a prehistory of Cork*. The Collins Press, Cork.

Ó Floinn, R. 2012. Annagh Cave. In M. Cahill and M. Sikora (eds), *Breaking ground, finding graves—reports on the excavations of burials by the National Museum of Ireland 1927–2006*, 17–47. National Museum of Ireland, Dublin.

Ó Ríordáin, S.P. 1948. Earthen barrows at Rathjordan, Co. Limerick. *Journal of the Cork Historical and Archaeological Society* 53, 19–32.

O'Sullivan, A. 2001. *Foragers, farmers and fishers in a coastal landscape: an intertidal archaeological survey of the Shannon Estuary.* Discovery Programme Monographs 5. Dublin.

O'Sullivan, J., Hallissey, M. and Roberts, J. 2002. *Human remains in Irish archaeology. Legal, scientific, planning and ethical implications*. The Heritage Council of Ireland, Kilkenny.

Roberts, C. and Manchester, K. 1995. *The archaeology of disease* (2nd edn). Sutton Publishing, Stroud.

Roche, H. 2016. Neolithic and Bronze Age pottery from Irish caves. In M. Dowd (ed.), *Underground archaeology: studies on human bones and artefacts from Ireland's caves*, 79–104. Oxbow Books, Oxford.

Rogers, J. and Waldron, T. 1995. *A field guide to joint disease in archaeology*. John Wiley and Sons, Chichester.

Ryan, M. 1980. An Early Mesolithic site in the Irish midlands. *Antiquity* 54 (210), 46–7.

Scheuer, L. and Black, S. 2000. *Developmental juvenile osteology*. Academic Press, London.

Schulting, R.J., Murphy, E., Jones, C. and Warren, G. 2012. New dates from the north and a proposed chronology for Irish court tombs. *Proceedings of the Royal Irish Academy* 112C, 1–54.

Smith, B.H. 1991. Standards of human tooth formation and dental age assessment. In M.A. Kelley and C.S. Larsen (eds), *Advances in dental anthropology*, 143–68. Wiley-Liss, New York.

Strogen, P. 1988. The Carboniferous lithostratigraphy of south-east County Limerick and the origins of the Shannon Trough. *Geological Journal* 23, 121–37.

Teacher, A.G.F., Garner, T.W.J. and Nichols, R.A. 2009. European phylogeography of the common frog (*Rana temporaria*): routes of postglacial colonisation into the British Isles, and evidence for an Irish glacial refugium. *Heredity* 102, 490–6.

Thomas, A. 1995. Killuragh Cave and others of east Limerick. *Irish Speleology* 15, 72–4.

Ubelaker, D.H. 1989. *Human skeletal remains: excavation, analysis, interpretation*. Taraxacum, Washington, DC.

Woodman, P.C. 1978. *The Mesolithic in Ireland*. British Archaeological Reports, British Series 58. Oxford.

Woodman, P.C. 1985. *Excavations at Mount Sandel, 1973–77*. Northern Ireland Archaeological Monographs 2. HMSO, Belfast.

Woodman, P.C. 1989. The Mesolithic of Munster: a preliminary assessment. In C. Bonsall (ed.), *The Mesolithic in Europe: papers presented at the 3rd international symposium*, 116–24. John Donald, Edinburgh.

Woodman, P.C. 1992. Towards a definition of Irish Early Neolithic assemblages. In N. Ashton and A. David (eds), *Stories in stone*, 213–18. Occasional Paper 4. Lithic Studies Society, London.

Woodman, P.C. 2012. Making yourself at home on an island: the first 1000 years(+?) of the Irish Mesolithic. *Proceedings of the Prehistoric Society* 78, 1–34.

Woodman, P.C. 2014. Ireland's native mammals: a survey of the archaeological evidence. In D.P. Sleeman, J. Carlsson and J.E.L. Carlsson (eds), *Mind the gap II: new insights into the Irish Postglacial*, 28–43. Irish Naturalists' Journal, Belfast.

Woodman, P.C. 2015. *Ireland's first settlers: time and the Mesolithic*. Oxbow Books, Oxford.

Woodman, P.C. 2016a. Mesolithic, Neolithic and Bronze Age lithics from Irish caves. In M. Dowd (ed.), *Underground archaeology: studies on human bones and artefacts from Ireland's caves*, 55–78. Oxbow Books, Oxford.

Woodman, P.C. 2016b. The introduction of cattle into prehistoric Ireland: a fresh perspective. In M. O'Connell, F. Kelly and J. McAdam (eds), *Cattle in ancient and modern Ireland: farming practices, environment and economy*, 12–26. Cambridge Scholars Publishing, Newcastle upon Tyne.

Woodman, P.C., Finlay, N. and Anderson, E. 2006. *The archaeology of a collection: the Keiller–Knowles Collection of the National Museum of Ireland*. National Museum of Ireland Monograph 2. Wordwell, Bray.

Woodman, P.C., McCarthy, M. and Monaghan, N. 1997. The Irish Quaternary Fauna Project. *Quaternary Science Reviews* 16, 129–59.