The role of caves in complex Neolithic funerary rituals on Knocknarea Mountain, Co. Sligo, Ireland

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In 2013, a small assemblage of commingled human bones representing at least two individuals of Neolithic date was recovered from a cave on Knocknarea Mountain, Co. Sligo. The find prompts a discussion of the value of examining small collections of human remains in relation to Neolithic multi-phase mortuary practices, particularly as non-megalithic funerary locations continue to remain underinvestigated and unidentified in Ireland. We explore the potential role of caves on Knocknarea Mountain as places for processing the dead prior to the secondary deposition of bones at other places in the landscape, including megalithic tombs. Such an approach encourages us to look at the wider funerary landscapes, both monumental and natural, that were recognised and used by Neolithic communities. We also outline the potential of archaeological predictive modelling in the identification of Neolithic cave sites.

INTRODUCTION

The recovery of a small deposit of commingled human bones, representing at least two individuals of Neolithic date, from a cave on Knocknarea Mountain, Co. Sligo, in 2013 prompted an exploration of the value of examining such assemblages and whether mortuary practices can be elucidated from such fragmentary remains (Table 1). We draw on Duday's (2009) work on archaeothanatology and Knüsel and Robb's (2016) discussion of funerary taphonomy, specifically the interpretation of commingled deposits of bone, with the aim of coming closer to identifying the 'dynamic processes' that led to the creation of this small assemblage. The discovery of Neolithic human remains in Irish caves is an infrequent occurrence. Apart from Knocknarea, the last such discovery was made in 1996 at Killuragh Cave, Co. Limerick (Woodman *et al.* 2018). The relative rarity of sites of this nature means that each new discovery warrants particular attention. The location of the cave on Knocknarea also raises questions about its potential relationship to a concentration of megalithic tombs on the mountain summit as well as to wider Neolithic funerary activities on the surrounding Cúil Írra Peninsula.

A COMMINGLED DEPOSIT OF BONE FROM KNOCKNAREA CAVE K

In 2013, two human foot phalanges were discovered lying exposed on the floor of Knocknarea Cave K, a small cave located at 235m OD, close to the summit of Knocknarea Mountain on the Cúil Írra Peninsula in Co. Sligo (Fig. 1).[1] This was not the first archaeological discovery in a cave on Knocknarea. In 2000, Stefan Bergh discovered an adult human occipital fragment (E998:501) on the floor of the adjacent Knocknarea Cave C. It was subsequently radiocarbon dated to the Neolithic period in a cave project led by Peter Woodman and Marion Dowd (Dowd 2008). Knocknarea Mountain dominates the local landscape, rising to 327m above the surrounding lowlands, which otherwise rarely exceed an altitude of 50m. The mountain has long been famed for the massive cairn, a probable passage tomb — Meascán Mhéabha (Queen Maeve's Cairn) — that crowns the summit. The entrance to Knocknarea Cave K is located on a steep slope on the north-western flanks of the mountain. A small entrance opening (0.4m by 0.3m) leads into a 2.5m-long stretch of cave passage, which is choked with organically rich colluvium that has most likely washed in from outside. The narrow entrance leads into a 24m-long passage that measures between 0.8m and 1m in width and between 0.5m and 1.5m in height. The cave floor is relatively level throughout. A narrow aperture 16m inside the entrance connects Knocknarea Cave K to a second parallel passage, Knocknarea Cave J (Fig. 2). A second connecting passage 9m inside the entrance of Cave K is currently choked with silt, preventing access between the two caves.

The discovery of the two human foot phalanges lying exposed on the western side of the cave floor, 10m and 11m inside the cave entrance, led to archaeological rescue works by two of the authors (Marion Dowd and Thorsten Kahlert), commissioned by the National Monuments Service (NMS). The project involved recording and lifting all human and

Fig. 1—Map of the the Cúil Írra Peninsula illustrating the location of caves on Knocknarea Mountain; the red dot marks the location of Knocknarea Cave K. The Carrowmore passage tomb cemetery is indicated to the east.

animal bones that lay exposed on the cave floor under licence 13E0427 (Dowd and Kahlert 2014).[2] No excavation took place and thus there can be little doubt that the recovered assemblage represents only a fraction of the true archaeological potential of the cave. The cave floor was also examined for artefacts and ecofacts but only a few charcoal flecks were found.

Animal bones

An assemblage of 213 highly fragmentary animal bones recovered from the cave was examined by zooarchaeologist Ruth F. Carden. The identifiable material included 101 rabbit, 7 rabbit/hare, 2 hare, 8 frog, 3 sheep/lamb, 3 sheep/goat, 1 sheep/cattle, 1 cattle, 1 woodmouse and 11 bird bones. The latter included domestic chicken (*Gallus gallus domesticus*), gamefowl (Galliformes sp.) and waterfowl (Anseriformes sp.) (Carden 2014). The bones of at least four rabbits, still containing fat and with carnivore gnawing, appear to represent prey consumed in the cave relatively recently, probably by foxes (*ibid.*). The lamb, domestic chicken and gamefowl bones may also represent fox prey, though human activities cannot be discounted.

The vast majority of the 213 animal bones from Knocknarea Cave K appear to relate to natural formation processes and prey activities of relatively recent date. However, a few animal bones may be archaeologically significant. Three mammal bone fragments (species unknown) displayed possible traces of burning. Additionally, a thin layer of calcium carbonate partially covered two juvenile sheep or goat metacarpals, a possible juvenile sheep or goat humerus, a calf pelvis, five fragments of medium or large sized mammals and a gamefowl humerus (*ibid.*). The calcium carbonate coating (which was also present on four human bones) indicates that these ten animal bones lay exposed on the cave floor for a long period of time and thus may be contemporaneous with, and possibly even related to, the same events as the human bones and associated ritual activities. The calf bone was radiocarbon dated as its presence in a mountain cave was deemed unusual and potentially reflective of human activities. It returned an Iron Age date of 2192±32 BP; 363–176 cal BC (Table 2). At present, this is the only known evidence of Iron Age activity on Knocknarea Mountain. As an isolated find, it is difficult

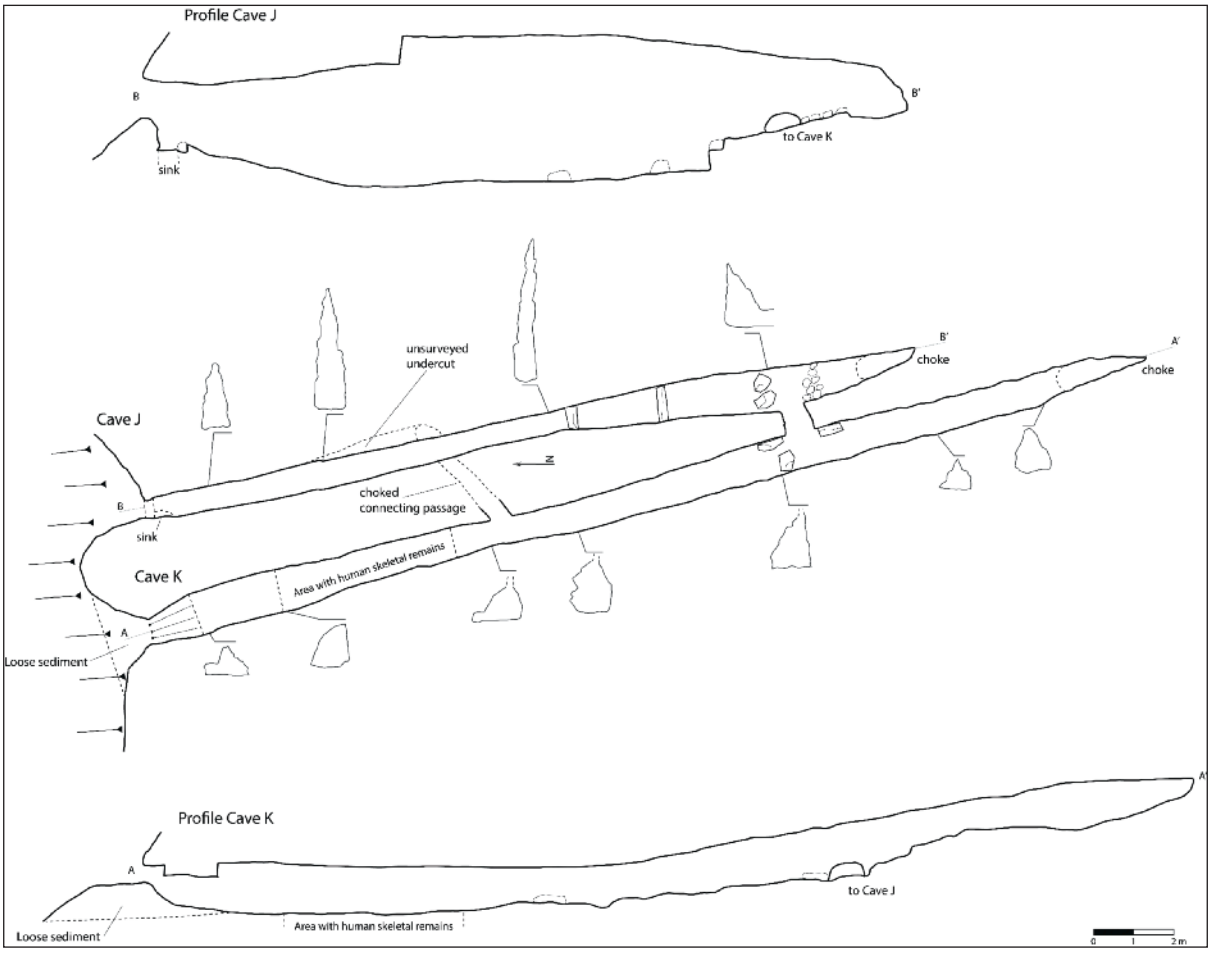

Fig. 2—Plan and profile drawing of Knocknarea Cave K and the adjacent Knocknarea Cave J (Kahlert 2016, 186).

to interpret what the calf bone represents. It is possible that Iron Age people visited the cave, but it may also comprise late prehistoric prey debris.

Human bones

Thirteen unburnt human bones were recovered scattered along a 2m stretch of the cave passage (Fig. 3) and were subject to osteoarchaeological analysis by one of the authors (McKenzie 2014). Six were complete or almost complete, while all others were fragmentary (Table 1). The surfaces of four bones were covered in calcium carbonate, suggesting that they had been exposed within the cave for long periods of time. Nine bones were dark brown in colour, apparently a consequence of waterlogging. The cave is not prone to flooding but in wet weather water drips through cracks in the walls and ceiling, forming small pools on the cave floor. There were signs that water pooled along the base of the cave walls and sides of the passage, which is where the recovered human bones were distributed. There was no evidence of animal or rodent gnawing, cut marks, modifications, scorching or burning on any of the human bones.

Age estimation of the adult skeletal elements was reliant upon epiphyseal fusion (Cardoso and Ríos 2011; Cunningham *et al.* 2016) to provide a minimum age-at-death of the individual(s). Degenerative age-related changes of the auricular surface of the ilium were assessed using the method developed by Lovejoy *et al.* (1985). In the juvenile remains it was not possible to record the stage of fusion of the ischiopubic rami as the ischium was damaged post mortem. Measurements were taken from the ilium and ischium and these were compared to juvenile skeletons from the medieval graveyard at Ballyhanna, Co. Donegal (McKenzie and Murphy 2018), to provide a crude estimate of age-at-death. Unfortunately, because many were incomplete (Table 1), it was not possible to attribute a sex estimate to any of the human bones from Knocknarea Cave K.

Osteoarchaeological analysis revealed that the Knocknarea Cave K assemblage represented at least one adult aged 30–39 years and one child aged approximately 4–6 years at the time of death. Two adult bones were radiocarbon dated. The resulting

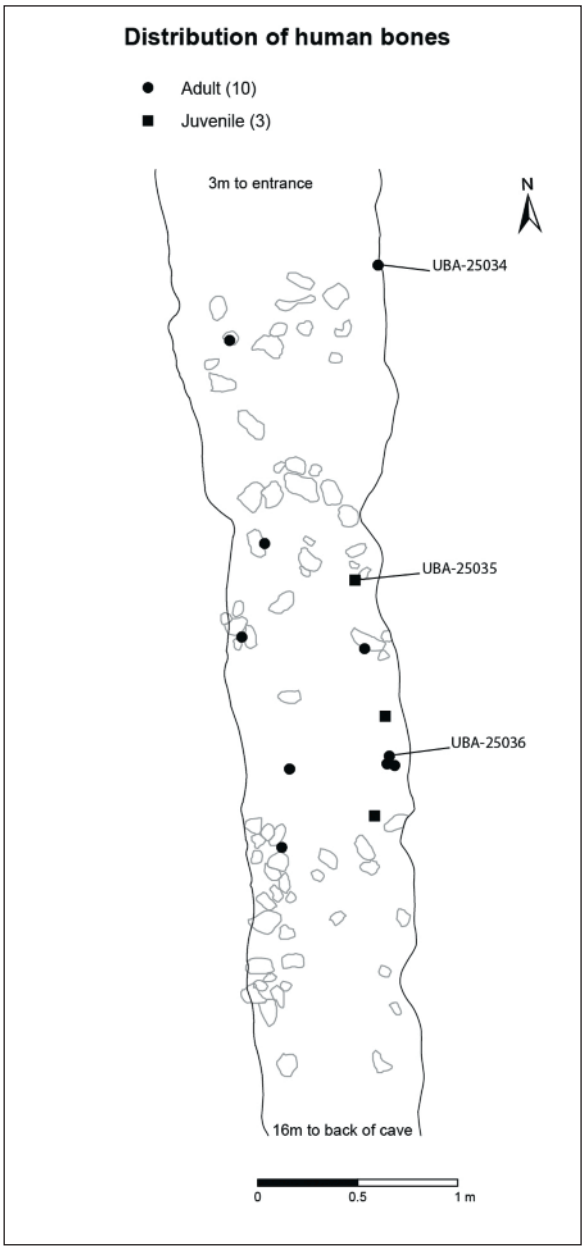

Fig. 3—Distribution of human bones in Knocknarea Cave K (after Kahlert 2016, 188).

determinations overlap, allowing for both to be from the same individual (Table 3), and there is no osteoarchaeological evidence to indicate that there is more than one adult. Only one probable pathological lesion was noted: a very small Schmorl's node on the inferior surface of an incomplete adult vertebra, likely indicating manual labour that involved stress or strain to the spine. An alternative explanation is that this indentation in the vertebral body may have been caused by a taphonomic process in antiquity.

The dates on the adult and child bones can be considered Middle Neolithic, falling between 3635 and 3010 cal. BC (Table 2). It is not possible to determine the time interval between the two individuals. They may have been placed in the cave no more than a few years apart, though they were potentially placed there several hundred years apart (Table 3). Stable isotope results suggest that the Knocknarea Cave K individuals relied primarily on a terrestrial diet, though the sample size is small and there were no contemporaneous baseline data from faunal remains that could be used for comparative purposes. However, wider Neolithic trends from Ireland and Britain suggest a dietary preference for terrestrial sources of food and the cultural rejection of marine resources (Schulting 2013; Cramp *et al.* 2014).

INTERPRETING COMMINGLED REMAINS

Interpreting commingled deposits of human bone is problematic as a wide range of taphonomic processes can result in a mass of mixed bones that derive from several individuals (Duday 2009; Knüsel and Robb 2016). At Knocknarea Cave K, 13 bones represented at least two individuals; the heaviest bone weighed just under 46g; and all the bones were unburnt (Table 1; Fig. 4). Notable features included the complete absence of any large skeletal elements, particularly limb bones (with the exception of a small ulna fragment) and skulls (apart from two small cranial fragments) (Table 1). The assemblage consisted primarily of small bone fragments and labile elements — that is, elements that disarticulate more quickly when connective soft tissues decompose (Knüsel and Robb 2016, 658, 662) — such as the cervical vertebra, rib and foot phalanges (Fig. 5). This assemblage mirrors a wider trend in the patterning of Neolithic human bones from Irish caves where small quantities of unburnt commingled bones, typically small and fragmentary elements, represent several individuals (Dowd 2008; 2015, Chapter 5).

When assessing the cultural practices that resulted in the presence of this small scatter of human bones in Knocknarea Cave K, certain possibilities can be dismissed. The small number of bones present (considering they derive from at least two individuals), the disarticulated nature of the material, and the complete absence of any anatomical correlation between the bones mean we can exclude the possibility of disturbed primary inhumation burials (based on the material recovered so far). This is further supported by the absence of any artefacts or grave goods accompanying the remains. Neither was there any trace of a grave cut in the clay floor. Secondary deposition of disarticulated remains collected from another location is possible, but unlikely, considering the very small size of the bones in question. That animal activities were

Table 1—Human bones from Knocknarea Cave K.

Code	Grid	Description	Completeness	Calcite	Weight
13E0427:01:001	10B	Adult proximal foot phalanx	100%		1.20g
13E0427:01:002	7A2	Adult lumbar vertebra (LV1/LV2)	100%	✓	45.96g
13E0427:01:003	8B3	Adult vertebra (with a Schmorl's node)	50%	✓	16.95g
13E0427:01:004	10A8	Juvenile ischium (left)	90%	✓	12.62g
13E0427:01:005	11A2	Adult rib (right)	25%		1.97g
13E0427:01:006	11B3	Adult proximal foot phalanx	100%		1.73g
13E0427:01:007	12A3	Juvenile thoracic vertebra	5%		0.34g
13E0427:01:008	12A4	Adult ilium (right)	25%		0.89g
13E0427:01:009	12A4	Adult cervical vertebra (CV7)	90%		38.79g
13E0427:01:010	12A6	Adult cranial fragment	<5%		13.87g
13E0427:01:011	12B6	Adult cranial fragment	<5%		0.86g
13E0427:01:012	13A3	Juvenile ilium (left)	100%		40.28g
13E0427:01:013	13B3	Adult ulna (right)	10%	✓	4.70g

Table 2—Radiocarbon dates on human and animal bones from Knocknarea Cave K and Knocknarea Cave C (Dowd and Kahlert 2014; Dowd 2015, 97).

Element	Lab code	$\delta^{13}C$	$\delta^{15}N$	C:N ratio	Collagen yield %	Measured radiocarbon years (BP)	Calibrated radiocarbon date BC (2σ)
Knocknarea Cave K							
Human. Adult ilium 13E0427:01:008	UBA-25036	-21.1	10.2	3.29	1.1	4734±39	3635–3497 0.699% 3453–3377 0.301%
Human. Adult lumbar vertebra (LV1/LV2)13E0427:01:002	UBA-25034	-21.1	10.4	3.26	8.7	4656±37	3620–3610 0.016% 3521–3361 0.984%
Human. Juvenile ischium 13E0427:01:004	UBA-25035	-21.7	10.9	3.27	3.5	4499±58	3368–3011 0.999% 2947–2945 0.001%
Cattle. Juvenile pelvis (os pubis) 13E0427:Grid 8	UBA-27258	-21.7	5.6	3.21	4.1	2192±32	363–176 1.000%
Knocknarea Cave C							
Human. Adult occipital	GrA-21493	-22.1	---	---	---	4740±50	3639–3496 0.663% 3461–3376 0.291%

Table 3—Plot of the radiocarbon dates on human bones from Knocknarea Cave K and Knocknarea Cave C.

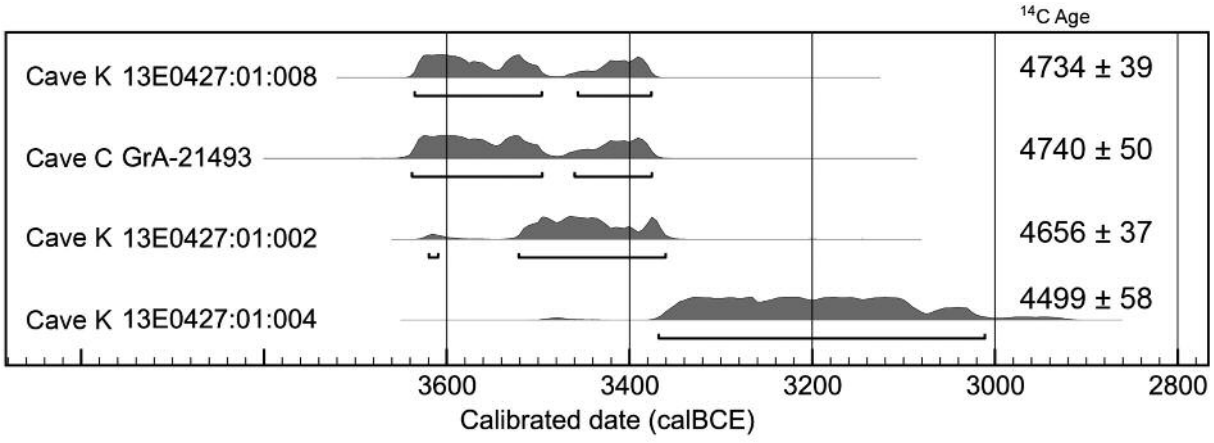

Fig. 4—Thirteen human bones representing at least one child and one adult from Knocknarea Cave K (T. Kahlert).

responsible for the presence of the human bones in the cave can be discounted based on the nature of the human bones, the body parts represented (no meat-bearing elements), the absence of animal gnawing and the clustering of radiocarbon dates in the Middle Neolithic.

A more plausible explanation is that these small fragments reflect the use of the cave for excarnation — where fleshed cadavers were laid on the cave floor and, following decomposition of soft tissue the larger skeletal elements were removed to a secondary location. The two cranial fragments recovered may represent damage to a skull caused by trampling and activity within the cave. Left behind in the cave were the small and fragmentary bones that are presumed to have been overlooked during the collection process. Residual bone — bone that remains on site after other processes have removed the greater part of the skeleton — such as that found at Knocknarea Cave K, is commonly encountered in the archaeological record but is typically overlooked and understudied (Knüsel and Robb 2016, 668). The presence of calcium carbonate on several bones from Knocknarea Cave K, in addition to discolouration owing to waterlogging, suggests that the corpses (and subsequently the skeletal remains) were never buried but were exposed to the internal micro-environment of the cave over a prolonged period. The cave provided a protected space wherein exposure and decomposition could take place undisturbed (particularly if the cave entrance was temporarily blocked, as has been suggested for other Neolithic excarnation cave sites — see Dowd 2008).

It is necessary to emphasise that only full archaeological excavation can corroborate the excarnation hypothesis that we put forward for this site. At present, all that can be said with confidence is that the cave was used for funerary or ritual activities involving at least two individuals during the Middle Neolithic.

Knocknarea Cave K was not used in isolation. An adult human cranial fragment of Neolithic date was discovered exposed on the floor of the adjacent Knocknarea Cave C, which is located some 50m from Knocknarea Cave K (Fig. 6). The radiocarbon date from Cave C is almost identical to one of the dates from Cave K, suggesting contemporaneous use of both caves, plausibly for similar purposes (Tables 2 and 3). The occipital fragment from Cave C does not overlap anatomically with the remains from Cave K, so we cannot exclude the possibility that the two bones derive from the same individual.

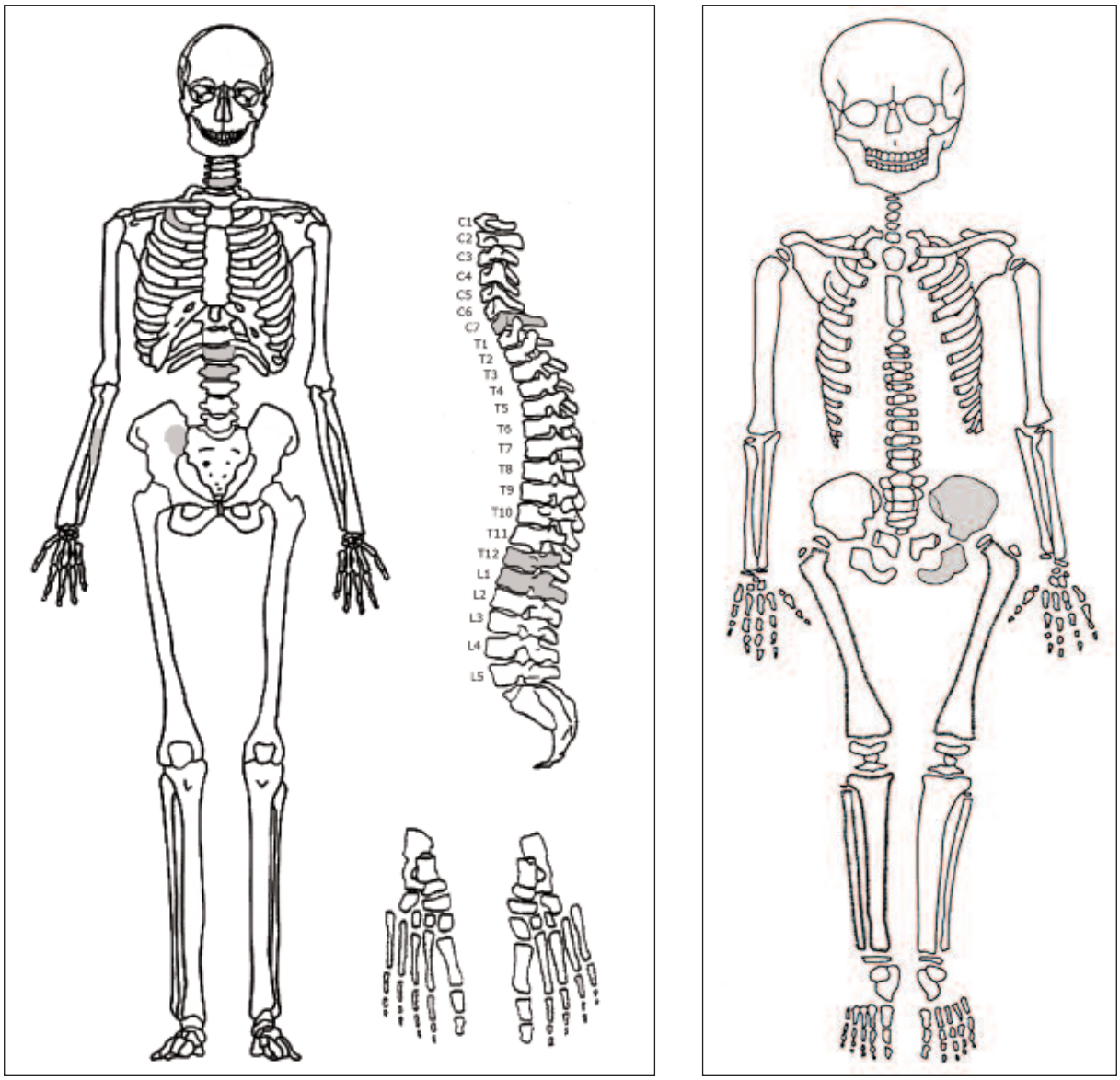

Fig. 5—Representation of skeletal elements recovered from Knocknarea Cave K (C. McKenzie).

EXPERIENCING RITUAL IN A MOUNTAIN CAVE: A WORKING HYPOTHESIS

Knocknarea is a 327m-high, flat-topped mountain that dominates the Cúil Írra Peninsula and commands expansive views over land and sea in all directions (Fig. 1). Twenty-nine caves and fissures are dotted along the western and northern slopes and cliffs of the mountain; fifteen of these are tightly clustered in terraced cliffs along the north-western side (Kahlert 2016, 180) (Fig. 6). The latter concentration includes Cave K and Cave C, which are located at heights of 235m and 254m OD respectively. The traditional and easiest route to the caves involves a 40-minute hike up the eastern slope, crossing the broad flat summit that passes the megalithic tombs, before descending some 45–50m down the north-west face to the caves. Caves K and C can also be reached following a more strenuous 30-minute ascent along the north-western slopes (Fig. 6).

If, as we conjecture, corpses were placed in the caves as part of excarnation rituals, both routes would have involved a relatively arduous uphill climb requiring several people to bear the weight of the corpse. An eastern ascent during the day could have been witnessed from numerous locales, such as the Carrowmore passage tomb complex, whereas the north-western slopes offered a more secluded route (Fig. 6). Getting a body into the cave would have required pushing it through the narrow entrance and dragging it along the passage. This would probably have

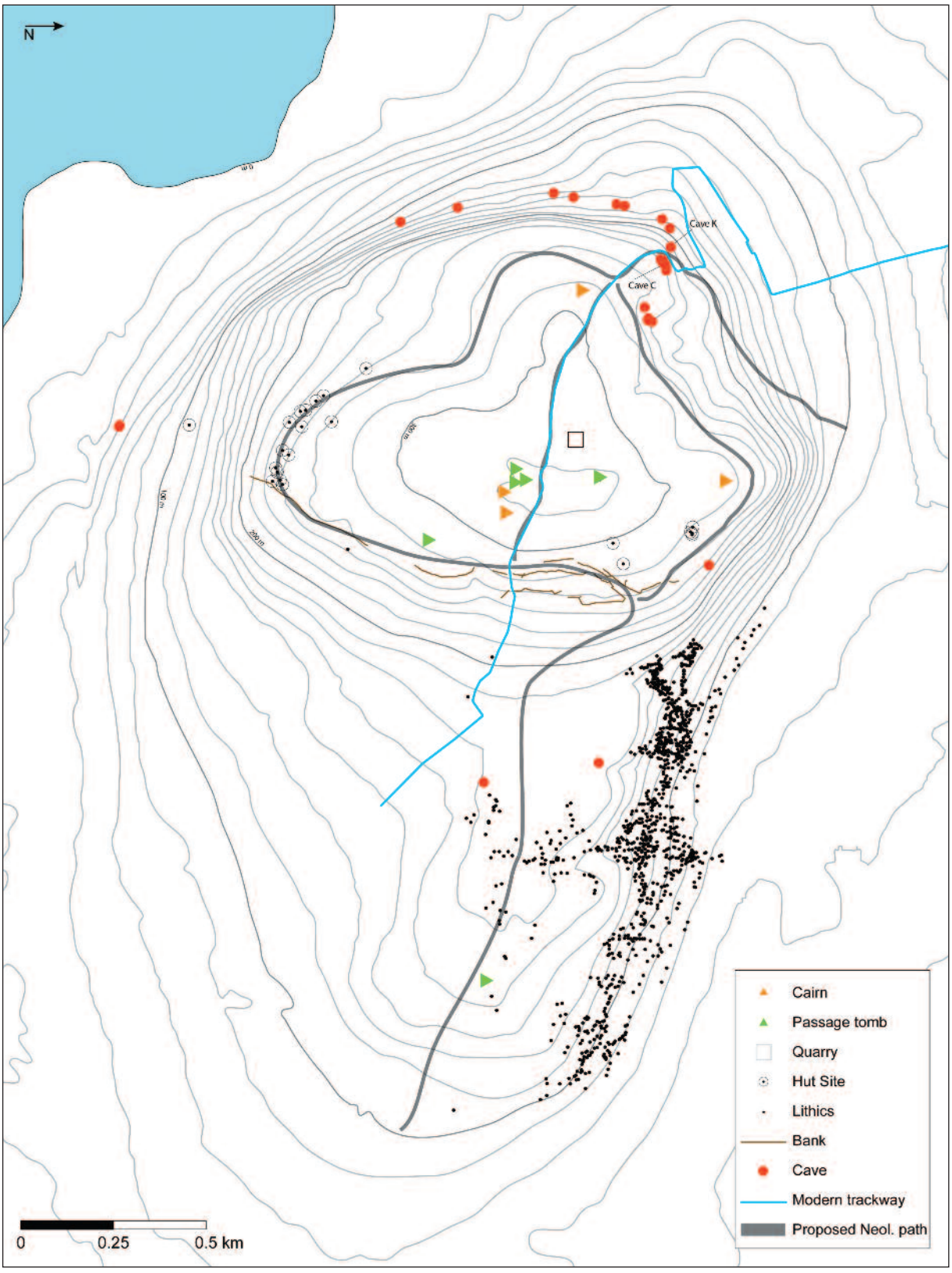

Fig. 6—Relationship between caves, megalithic tombs and known Neolithic activity on Knocknarea Mountain. The two most likely routes to Knocknarea Cave K are highlighted (Kahlert 2016, 193).

Fig. 7—T. Kahlert entering Knocknarea Cave K during the 2013 excavation (Dowd 2015, 7).

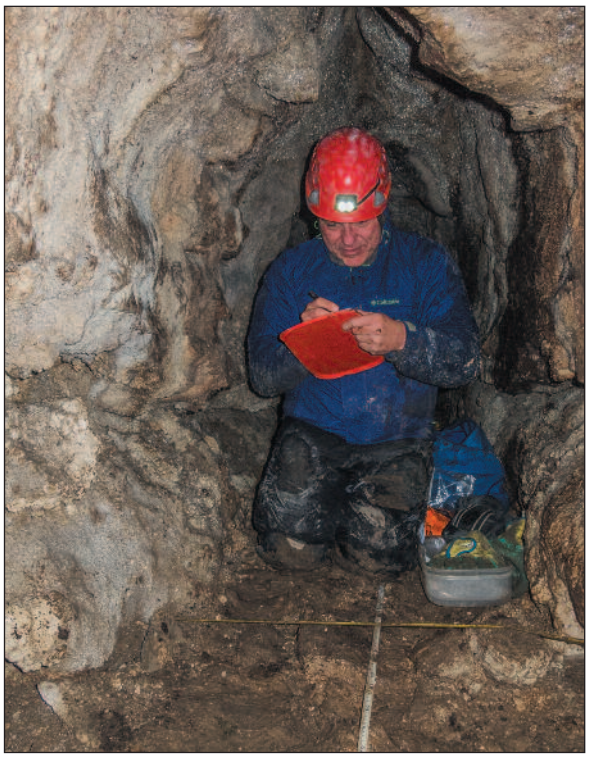

Fig. 8—The cramped nature of Knocknarea Cave K as evident during bone recovery in 2013 (M. Dowd).

required two people — one inside and one outside the cave (Fig. 7). Even if the entrance was clear of the sediments that currently block it, the cramped and extremely narrow morphology of the cave would not have permitted a gathering of people to witness the funerary ritual or offer assistance in the process (Fig. 8). At most, only two or three individuals could have been inside the cave with the corpse, although potentially just one person could have manoeuvred the corpse once it was inside. The event would have involved close physical contact between the living and the dead in an extremely cramped space. While some form of artificial light (e.g. a wooden torch) may have been used, as suggested by the tiny quantity of charcoal recovered, its effectiveness would have been limited by the confined nature of the cave. Ritual participants would also have blocked any natural light coming from the entrance. Close interaction with the dead would have been intensified by the heightened sensory experiences available within the darkness of the cave (see Dowd 2015, Chapter 1). The introduction of a corpse into the cave would have disturbed and dispersed any skeletal remains already located on the cave floor related to earlier periods of ritual activities, which could explain the scattered and fragmented nature of some of the recovered bones.

Caves that comprise simple long and narrow passages were deliberately sought out as places in which to conduct funerary activities during the Neolithic (Dowd 2008; 2015, Chapter 5; Kahlert 2016). Part of this preference may lie in the fact that the entrances of such caves are easier to block, thereby preventing decomposing bodies from being disturbed by scavenging animals. This is borne out by the absence of animal gnawing on any human bones of Neolithic date from Irish caves (Dowd *et al.* 2006; Dowd 2008; 2015; Fibiger 2016). Considering the fact that Irish caves maintain an average temperature of about 12°C throughout the year, a fleshed corpse exposed on a cave floor could have fully putrefied in approximately 18 weeks (Vass 2001). This estimate is, of course, fraught with variables, including humidity, soil pH, trauma to the body, insect access, size and weight of the corpse, clothing etc. (Mann *et al.* 1990, 105–8). The exclusion of carnivores, for instance, slows down the rate of decomposition. Nonetheless, it would be reasonable to suggest that an intact fleshed cadaver left on the floor of Knocknarea Cave K would be skeletonised within a period of 4.5 to 6.5 months. Following this stage, the larger and more visible skeletal remains could have been gathered up and moved to a secondary location. Left behind in the cave were the small and fragmented elements that escaped attention.

This leaves us with a question: what happened to the larger, more robust bones?

CAVES AND CAIRNS IN SLIGO

The Cúil Írra Peninsula has been described by Bergh (2002, 144) as 'one of the major cultural and ritual centres in Neolithic Ireland'. The Carrowmore complex is centrally located within the peninsula and comprises 30–40 passage tombs and related monuments extending over an area of 1km by 0.5km (Wood-Martin 1887; Bergh 1995; 2002). Knocknarea Mountain, at the western end of the peninsula, dominates the entire region. On its summit is the large cairn of Meascán Mhéabha (60m in diameter and 10m in height), which commands expansive views over the landscape and, in turn, is visible from great distances. It is one of at least five probable passage tombs located on a north–south axis on the mountain top (Bergh 2002, 146). Meascán Mhéabha was constructed to give maximum visibility when viewed from the east, particularly from Carrowmore, yet it is almost completely obscured from view from the north and north-east (Bergh 1995, 135; 2002, 146–8).

The Knocknarea Archaeological Project carried out extensive field-walking, field survey, trial excavation, geophysical survey and digital survey of the prehistoric sites and topography of Knocknarea Mountain in 1999–2000 (Bergh 2000). This resulted in the discovery and investigation of: 25 hut sites and hut-like features dated to *c.* 3000 BC; four low cairns or stone spreads; an earthen mound; and 2.5km of discontinuous earthen banks and walls of Neolithic date (Fig. 6). The banks occur 100–150m below the summit and along the 270m contour on the eastern side of the mountain, creating a division between an upper ritual area and a lower zone (Bergh 1995; 2002, 146–9).

Despite the intensive nature of the project, none of the 27 caves located around the mountain was recorded or investigated, arguably mirroring the traditional focus of prehistorians on constructed monuments rather than topographic features. While this opposition between natural and cultural has been challenged in recent scholarship (e.g. Bradley 2000; Fowler 2010), it still persists. Indeed, caves on the Cúil Írra Peninsula have never been mentioned or considered by any of the scholars who have studied this rich megalithic landscape (e.g. Wood-Martin 1887; Burenhult 1980; Bergh 1995; 2002). The archaeological evidence, however, hints that this separation is a modern construct and does not reflect the Neolithic interconnectedness that once existed.

The bone finds from Knocknarea Cave K and Knocknarea Cave C imply a relationship between caves and constructed monuments on the mountain. For instance, if people accessed the caves from the eastern side of Knocknarea they would have navigated the discontinuous earthen banks with their associated huts, and later walked past the megaliths on the mountain summit, before dropping downslope towards the north-west to the caves. Bergh (2009, 107–11) has argued that the huts may have witnessed short-term occupation as part of special visits to the monuments on the mountain summit. He suggested that the chert concave scrapers and debitage found within the hut sites relate to activities at the megaliths on the mountain top, and specifically that the scrapers were potentially used for defleshing the dead. Caves may have played a role in such multi-stage and multi-locational mortuary rituals; there may have been a direct relationship between activities in the huts and activities in the caves. Meascán Mhéabha has never been excavated but is almost certainly Middle Neolithic in date, *c.* 3000 BC (Bergh 2002), making it broadly contemporaneous with the dated human bones from Cave K and Cave C. Human remains from passage tombs typically occur as token disarticulated deposits, sometimes cremated and sometimes unburnt (Cooney 2017). We rarely consider the provenance of secondary bone deposits found in Neolithic monuments, but the caves on Knocknarea Mountain suggest a likely origin point for human bones found in the megalithic tombs on the summit.

Meascán Mhéabha and the other tombs on the summit of Knocknarea, with their distinctive eastern orientation, essentially turn their back to the sea and are focussed on the Carrowmore passage tomb complex (Bergh 2002, 148). Bergh likens this deliberate positioning of the monuments within the natural setting as 'reminiscent of a stage set, where there is a clear division between front and back'. As he notes, the massive quarry that provided the stones for the cairn is located 'backstage', some 100m west of Meascán Mhéabha (*ibid*.). Neolithic people may have perceived this western part of the mountain as the working/processing/industrial side. If so, it is fitting that caves only occur on this western side. These liminal and transitory places were on the margins of the living world. Here, corpses or body parts may have been temporarily placed, and potentially prepared and processed prior to deposition in the megalithic tombs on the summit (Kahlert 2016). The dead were thus removed from sight and from society. Months later the deceased may have been brought back into view and memory by having their bones incorporated into the highly visible monuments on the mountain-top.

Considering the relationship between Meascán Mhéabha and the Carrowmore complex, we must also consider whether caves on Knocknarea Mountain played a role in multi-phase mortuary rituals in the wider Cúil Írra Peninsula. One of the Carrowmore monuments provides a tentative cave connection. Nineteenth century excavations at Tomb 49 produced cremated and unburnt human bones, in addition to 'Eight cylindrical crystalline bodies from 7/16 to 15/16

inch in length, rough externally; the central axis crystalline (carbonate of lime). These appear to be stalactitic formations' (Wood-Martin 1887, 590). This description suggests that these items, now lost, were stalactite straws, which could only have originated in a cave. Thus, other material (e.g. human bone) found in Tomb 49 may also have been brought from caves.

A relationship between megalithic monuments and caves has also been suggested for the passage tomb complex at Carrowkeel in the Bricklieve Mountains, some 27km south-east of Knocknarea (Dowd 2015, 111; Kahlert 2016, 149–62). Recent reassessment of the human remains from Carrowkeel places activities in these monuments primarily in the Middle Neolithic, *c.* 3500–2900 cal. BC (Hensey *et al.* 2014; Geber *et al.* 2016). Unburnt and cremated bone from 7 of the passage tombs revealed a minimum of up to 40 individuals (18 from unburnt bone, 22 from cremated remains), including adults and juveniles. There was a higher representation of large skeletal elements and a lower presence of small skeletal elements in the tombs than would typically be expected (*ibid.*). This points towards the secondary deposition of commingled remains that were gathered from primary funerary processing sites elsewhere (e.g. cremation pyres, excarnation sites, dismemberment sites) (Geber *et al.* 2017, 46). The Carrowkeel data reinforce the complex nature and combinations of mortuary practices evident within the wider Irish passage tomb tradition (Cooney 2017).

The locations of the primary processing sites remain unknown, although some of the 36 caves recorded in the Carrowkeel/Keshcorran area may have been used (Kahlert 2016, 151). None of the human bones from Carrowkeel was coated in calcium carbonate (Geber *et al.* 2017, 38), but this does not necessarily exclude the use of caves for primary deposition because calcite accretions are the consequence of very lengthy periods of exposure within a cave. Archaeological excavation in some of the caves within the Carrowkeel complex, particularly those in close proximity to passage tombs, might resolve this question. Predictive modelling (see below) has indicated that Treanscrabbagh Cave, located some 160m north-west of Cairn B at Carrowkeel, has a high likelihood score of having been selected for use in the Neolithic (Kahlert 2016, 152). Another promising site is Parallel Cave, located 100m west of Cairn P at Carrowkeel (*ibid.*, 154).

PREDICTIVE MODELLING AND THE FUTURE OF CAVE RESEARCH

The human bones from Knocknarea Cave K were found in the course of an archaeological survey of 96 caves located within six research areas in Counties Sligo and Leitrim that cover a total area of 82.7km^2. This was the core of doctoral research on the potential of geographic information systems, predictive modelling and morphological analysis to identify caves that were likely to have been used for funerary purposes in Neolithic Ireland (Kahlert 2016). One of the six research areas was Knocknarea Mountain. Of the 27 caves that were reported on the mountain (Coleman 1965, 56; Wilson 1965; Drew 2006), 9 were excluded — either because they were too small (less than 2m in length) or because they could not be located owing to inaccurate georeferencing.

This left 18 caves for analysis. The predictor variables assessed in the predictive model included length, height, complexity (i.e. a simple passage or a network of interconnected chambers and passages), entrance size, number of openings/entrances and entrance orientation (Kahlert 2016, Chapter 5). Analysis indicated that the caves with the greatest likelihood of containing human bone of Neolithic date consist of a single small entrance, orientated north to east, leading into a simple low passage less than 20m in length. These findings were in concordance with some of the preferences noted by Dowd (2008) as to the types of caves sought out by Neolithic people for conducting specific funerary rituals.

The model assigned likelihood scores on a scale from 0.109 to 0.768, which means that the highest-scoring cave (Knocknarea Cave R) is predicted to be seven times more likely to have been used for funerary activity during the Neolithic than the lowest-scoring cave (Knocknarea Cave E) (Table 4). While the model assigned a relative low likelihood score to Knocknarea Cave K, it correctly predicted that Knocknarea Cave C was likely to have been used during the Neolithic. Knocknarea Cave R (200m east of Cave K) shares many morphological traits with Caves K and C and received a high likelihood score of 0.762, making it the most promising candidate for archaeological prospection among the caves that formed part of the research (Fig. 9). The model requires real-life testing through archaeological excavation of the most likely candidates to confirm the positive predictions, as well as limited testing at the least likely sites to confirm negative predictions.

CONCLUSIONS: READING TOO MUCH INTO TOO LITTLE?

Knüsel and Robb (2016) drew attention to the archaeological neglect of certain funerary practices and deposits of human bone that deviate from the familiar 'burial' and 'cremation' categories. Indeed, many skeletal samples remain uninvestigated because they are

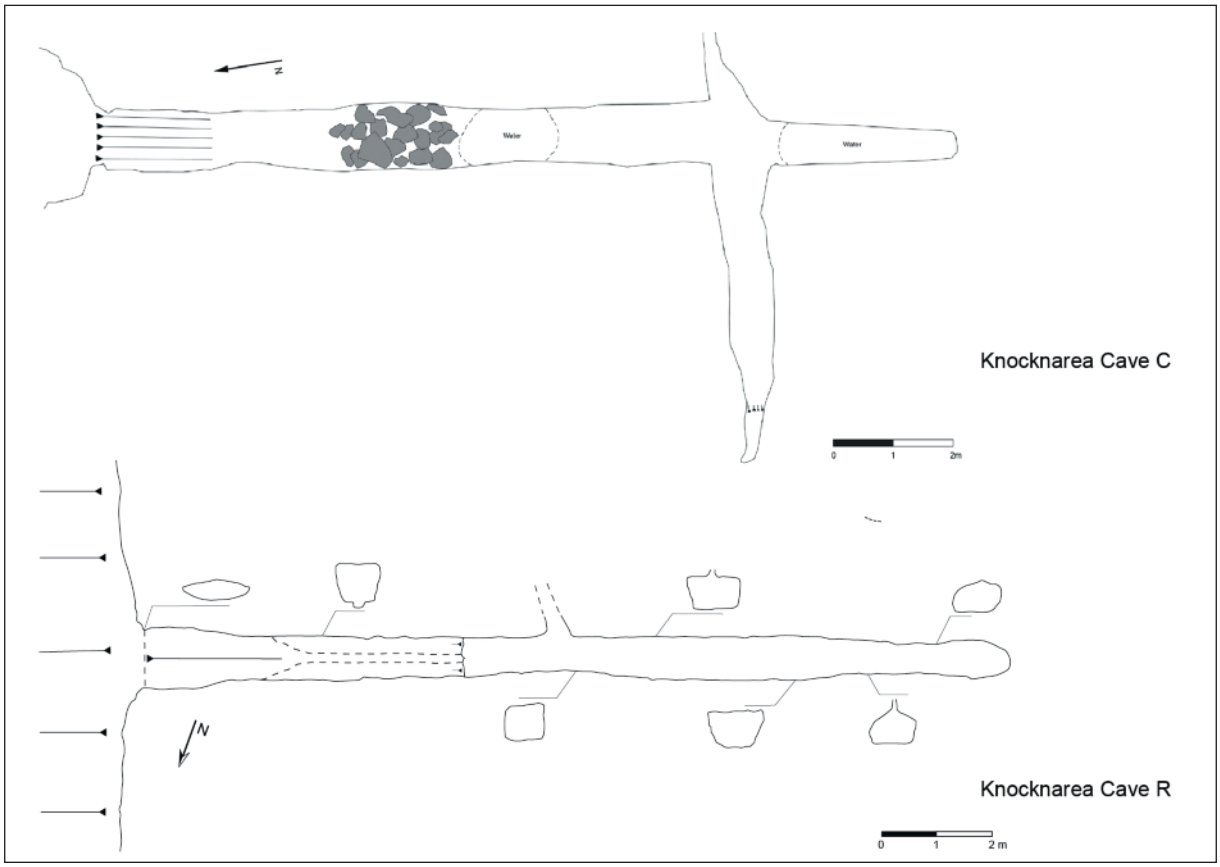

Fig. 9—Plans of Knocknarea Cave C and Knocknarea Cave R (Kahlert 2016, 176).

Table 4—Predictive modelling results from caves at Knocknarea (Kahlert 2016, 148).

Cave name	Complexity	Entrance dimensions	Passage height	Openings category	Length category	Orientation category	Likelihood score
Knocknarea Cave R	1	1	1	1	1	1	0.762
Knocknarea Cave A	1	1	2	1	1	1	0.747
Knocknarea Cave B	1	1	2	1	1	1	0.747
Knocknarea Cave C	1	1	2	1	1	1	0.747
Knocknarea Cave F	1	1	3	1	1	1	0.655
Knocknarea Cave G	1	1	3	1	1	1	0.655
Knocknarea Cave N	1	3	2	1	1	6	0.635
Knocknarea Cave V	1	1	1	1	0	5	0.62
Knocknarea Cave D	1	1	2	1	0	1	0.616
Knocknarea Cave K	1	1	1	2	2	1	0.609
Knocknarea Cave J	1	1	3	2	1	1	0.575
Culleenduff Cave 2	1	1	3	2	1	5	0.563
Culleenduff Cave 3	1	1	3	1	0	5	0.512
Knocknarea Cave H	1	3	3	1	2	1	0.486
Knocknarea Cave I	1	3	3	1	0	1	0.428
Knocknarea Cave O	1	3	3	2	0	1	0.348
Culleenduff Cave 1	1	3	3	2	0	5	0.337
Knocknarea Cave E	2	3	3	3	1	1	0.328

perceived as too small or too fragmented to repay study; some have even been discarded as worthless (*ibid*., 656). Similar observations have been noted for Irish prehistoric cave assemblages (Dowd 2015), but the potential of what such material can illustrate about Neolithic mortuary practices (as well from other periods) has been demonstrated through detailed osteoarchaeological analysis of the surviving human bone assemblages (Fibiger 2016; Dowd 2015, Chapter 5). The authors faced the same dilemma when considering the 13 bones from Knocknarea Cave K. Did this small assemblage warrant publication, or should it be simply filed away as an unpublished report? It was decided that this site does have value, not least because it is the first Irish cave to produce Neolithic human bone in almost two decades.

Whittle was not alone in his assertion that across Europe non-megalithic funerary practices and places 'have been treated as a sideshow to the action taking place in the built "tombs", as of lesser interest or as curiosities' (1996, 243). From the eighteenth to the early twentieth century, megalithic tombs constituted the only surviving above-ground evidence of Neolithic populations in Ireland. Little surprise, then, that they garnered so much scholarly attention. Yet the continued focus on megalithic monuments in Neolithic archaeological research, and particularly the most elaborate form of these monuments — passage tombs — is grossly misleading. The result is that natural places that featured in related funerary rituals tend to be sidelined. Sites such as Knocknarea Cave K challenge us to rethink the traditional research bias and prompt further investigation into the role of caves and other natural places in Neolithic mortuary practices. Key to this is an exploration of the interplay between monuments and natural places when we encounter evidence of multi-phase and multi-location funerary practices.

The presence of human bones in at least two caves on Knocknarea Mountain allows us to hypothesise that caves played a role in complex Neolithic funerary rites that involved various stages, each resulting in a particular archaeological signature. Caves are known to have been used for funerary rituals including excarnation elsewhere in Ireland during the Neolithic (Dowd 2008; 2015), but such sites do not occur in regions with megalithic monuments, unlike Knocknarea. We surmise that megalithic tombs on the summit of Knocknarea Mountain received secondary deposits of disarticulated bone that had been processed inside caves on the mountain. While Knocknarea Cave K and C await larger scale excavation to substantiate or refute our hypothesis, their case at the very least strongly suggests that funerary rites among megalithic tomb builders were not restricted to constructed sites and complexes. Natural places such as caves were utilised in the treatment and processing of the dead to a much greater degree than is currently appreciated. Rather than passively waiting for the next discovery of Neolithic human bones in a cave, we must actively further this research area by targeting caves that techniques such as predictive modelling have identified as likely to repay investigation.

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NOTES

[1] Location: Carrowbunnaun townland; ITM 561959/834938; NGR 161999/334932. Prior to the 2013 discovery, the cave was not known to be of archaeological significance, but has since been registered as an archaeological site (SL014-288——).

[2] The phalanges were discovered by T. Kahlert in the course of doctoral research supervised by M. Dowd and funded by the Irish Research Council. The subsequent rescue excavation was a joint project carried out under licence 13E0427 and fully funded by the NMS under their rescue excavation budget (licence holder M. Dowd).