

¹⁰¹ Postmortem Processing of the Dead at the Carrowkeel Passage Tomb Complex
Facilitating Transitions: Postmortem¹⁰² Processing of the Dead at the Carrowkeel
Passage Tomb Complex, Ireland (3500–3000 cal B.C.)

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¹⁰¹ Authors: Please do not use Word's Comment function while reviewing the editing of
this article.

¹⁰² We're following American spellings and hyphenation practices per Webster's *11th
Collegiate* and *Third New International*: postmortem (both adjective and noun), reassess,
reexamine, cut marks, deflesh, body processing, and so forth.

¹⁰⁴ Please confirm that you wish to abbreviate "County" here and on the next line; it's
always spelled out in the text.

<ab>This study explores the burial practices and secondary funerary rites at the Carrowkeel Neolithic passage tomb complex in County Sligo in northwest Ireland. An osteological and taphonomic reassessment of cremated and unburned¹⁰⁵ human bones recovered from the complex during an archaeological excavation more than a century ago has produced significant new insights into how the people of Carrowkeel perceived death and how they maintained and manifested social links with their ancestors. In addition to the rite of cremation, a complex postmortem burial practice is further attested by the presence of cut marks on several of the unburned bones, which indicate that the bodies of the dead were dismembered before they were placed in the tombs. It is argued that both cremation and dismemberment (and possible defleshing) may have been physical expressions of similar objectives, relating to excarnation and removal of flesh from the bodies of the deceased. Processing the bodies and thereby assisting the dead to transcend to an extra-bodily realm of existence may have been the main focus of the burial rite. The passage tombs at Carrowkeel should perhaps be viewed as places of curation, transformation, and regeneration of enduring ancestors that enabled both a physical and spiritual interaction with the dead and allowed for their omnipresence among the living.

¹⁰⁶<txt>Ireland has a rich prehistoric archaeological record. This abundance is particularly evident in the substantial number of surviving Neolithic funerary monuments (Scarre *2007; Shee Twohig *2004). Apart from the well-known passage tombs, these also include portal tombs, court tombs, so-called Linkardstown-type tombs and other unclassified megalithic monuments (Cooney *2000; Jones *2013; Shee Twohig *2004).

¹⁰⁵ “unburned” is the preferred American spelling.

¹⁰⁶ The journal doesn’t use the “Introduction” heading immediately after the abstract.

The dead were also placed in caves (Dowd *2008). The diversity in modes of burial suggests that the perceptions of death and the afterlife in the Neolithic changed in tandem with and as a consequence of social changes (Bradley *2007; Parker Pearson *1999; Whittle *1996). Societal change is implicit in the sudden appearance (a “frenzy” of construction [Scarre *2010:183]) of a variety of megalithic funerary monuments and communal tombs beginning in the Neolithic period. Over the period when passage tombs were constructed in Ireland, a decrease in the archaeological evidence of settlement is observed, which suggests substantial societal and economic shifts occurred simultaneously (McLaughlin et al. *2016). A sense of transformation--in particular, shifting perceptions of death and the afterlife--is also apparent in the changing funerary practices relating to the treatment of the dead and how their mortal remains were perceived by society. It is evident that postmortem processing and diverse secondary burial practices were particularly important funerary rites for Neolithic societies (see Crozier *2016; Fowler *2010; Murphy *2003; Reilly *2003; Robb et al. *2015).

This study discusses new evidence of body-processing¹⁰⁷ and secondary funerary rites undertaken in the Irish Neolithic as revealed from an osteological and taphonomic reanalysis of human bones excavated at the Carrowkeel passage tomb complex in County Sligo more than a century ago. The complex at Carrowkeel includes 26 passage tombs and probable passage tomb tradition sites (Hensey et al. *2014), as well as over 150 enclosures/hut sites within an area of about 25 km² (Bergh *2015) (Fig. 1). The tombs/monuments are prominently situated in the Bricklieve Mountains with panoramic views of the surrounding landscape. In addition to this impressive topographical location, the investment of imagination and energy that produced the remarkable diversity of forms

¹⁰⁷ “body-processing” is modifying “rites” here, correct? (“body-processing rites and secondary funerary rites”) Yes (or ‘body processing’ would work too, I suppose)

and the scale of its monuments indicates¹⁰⁸ that Carrowkeel had a particularly important role and function in this region in the Neolithic. Despite this situation, the complex has been subjected to far less modern research than¹⁰⁹ its more famous counterparts:

Loughcrew and the Boyne Valley ¹¹⁰(Brú na Bóinne) in County Meath in the east of Ireland (e.g., Eogan *1986; O’Kelly *1982; Shee Twohig et al. *2010; Smyth *2009), and Carrowmore in County Sligo (Bergh *1995; Bergh and Hensey *2013; Burenhult *1984, *2003). {figure 1 here }

<a>Archaeological Background

<txt>The first substantial archaeological investigation of Carrowkeel was conducted in the late spring and summer of 1911. The excavation was directed by Robert ¹¹¹Alexander Stewart Macalister (1870<n>1950), professor of celtic archaeology¹¹² at University College Dublin, assisted by Robert Lloyd Praeger (1865<n>1953), a naturalist, writer, and librarian at the National Library of Ireland, and Edmund Clarence Richard Armstrong (1879<n>1923), assistant keeper of antiquities at the National Museum of Ireland. During a total of only 18 days, and with the help of local laborers, the team investigated and described 14 cairns (Fig. 2). They also recorded two megalithic structures and a large

¹⁰⁸ “investment” is the subject

¹⁰⁹ OK? We had “comparably little ... compared to”; is “far less” accurate? (it’s imprecise, but I wonder if just “less” would be safer) That sound good!

¹¹⁰ No italics for proper nouns.

¹¹¹ Perhaps just abbreviate middle name as “A.”? See below regarding the use of “Sr.” But I find that he had two “middle” names, the second being “Stewart”, and that he published under the name “R. A. Stewart Macalister”. He was always known as R.A.S. Macalister in Ireland, so it is better to refer to him as that rather than as ‘Robert Macalister’

¹¹² ‘Professor of Celtic Archaeology’ is a title, so should have capital letters???

group of enclosures/hut sites (Hensey et al. *2014; Macalister et al. *1912). A substantial amount of human and animal bone, together with a small collection of pottery, bone, and stone artifacts, was recovered. The skeletal material was analyzed by R. A. S.

Macalister's father, Alexander Macalister ¹¹³(1844-1919), professor of anatomy at the University of Cambridge, who was also present during some of the archaeological excavations. Alexander Macalister's analysis of the remains was published as a summary in the excavation report in the *Proceedings of the Royal Irish Academy* in early 1912, only a few months after the excavation was concluded (Macalister et al. *1912).

Radiocarbon dates obtained from human and animal bones recovered from within the passage tombs in later studies have consistently returned Middle to Late Neolithic dates (3600-2500 cal B.C.) (Bergh *1995; Hensey et al. *2014; Kador et al. *2015), although the area continued to be used for funerary purposes well into the Bronze Age, as indicated by cist burials and Bronze Age pottery vessels associated with some of the monuments (Hensey et al. *2014). {figure 2 here}

<a>Osteological Material and Methods

<txt>The human bone assemblage from Macalister's excavations at Carrowkeel is curated by the Duckworth Laboratory at the Leverhulme Centre for Human Evolutionary Studies (LCHES), University of Cambridge, England. A small amount of material is also

¹¹³ I don't see a reason to call him "Sr.," since his first name is different from his son Robert's (Jr. and Sr. typically refer to father and son having same first name, of course). If there was another son named Alexander, he would be Alexander Jr., but that isn't relevant to this context. To avoid confusion about the names, let's call him Alexander Macalister and his son Robert (or R. A. S.) Macalister. Ok. But his son should be referred to as R. A. S. Macalister, rather than as 'Robert Macalister' (see my comment above)

held by the National Museum of Ireland (NMI) in Dublin, Ireland. For a long time,¹¹⁴ the whereabouts of the Cambridge assemblage was unknown to Irish archaeologists, and the bones have not been studied since the original analysis in 1911 (discussed in Hensey et al. *2014). The material comprises 5.7 kg (2,344 fragments) of cremated and 9.7 kg (755 fragments) of unburned commingled remains that had been recovered from up to seven¹¹⁵ individual passage tombs. Some of the curated Carrowkeel are from uncertain tombs contexts, and these have been labelled as ‘Cairn B or G’, ‘Cairn E or F’, ‘Cairn H, K or O’ and ‘Cairn ?’ (Table 1). The bones were macroscopically analyzed in a well-lit laboratory environment, with the occasional aid of a magnifying glass, following standard osteological guidelines and protocols (Brickley and McKinley *2004; Buikstra and Ubelaker *1994). Age at death was estimated from bone measurements of neonatal and infant remains and by epiphyseal fusion of juveniles and adults (Scheuer and Black *2000; Szilvássy *1988). Sex was determined from pelvic and cranial morphological features (Sjøvold *1988). Bone surface analysis with the aid of a scanning electron microscope¹¹⁶ was not available for this study. {table 1 here}

The degree of incineration of the cremated bones and the condition of the unburned bone were determined and classified according to the descriptions by Wahl (*1982) and McKinley (*2004). The relative fragmentation of the cremated and unburned

¹¹⁴ How long? The bones were ‘rediscovered’ in Cambridge in 2003, so that would be 92 years since after the excavation in 1911. However, we have no idea of when exactly the Irish archaeology community would have lost awareness of their location. Presumably, the archaeologists involved in the excavation in 1911 would have known where they were after the project was completed...

¹¹⁵ Do we need to clarify the dual naming of some of the cairns, e.g., Cairn B/G? See my explanation in the text

¹¹⁶ No need to introduce abbreviations that aren’t used subsequently in the text; they’re explained in the tables.

samples was assessed by considering both the average weight per fragment ¹¹⁷and the ratio of the number of fragments (NISP) to the minimum number of elements (MNE) (Lyman 1994:336-338).¹ Bone fragment weight was measured using an electronic digital scale with 0.01 g accuracy (OHAUS Scout Pro).

<a>Result

<txt>Cremated and unburned bones are present in nearly equal proportions when quantified by the minimum number of individuals (MNI), with at least 22 individuals present in the cremated and 18 individuals present in the unburned material. These samples include remains of both non-adults and adult males and females (Geber et al. *2016). By context, the largest quantity of the unburned bone assemblage derives from Cairn K and the smallest amounts from Cairn F (Table 1). The assemblage is characterized by its taphonomic uniformity in appearance and its generally excellent state of preservation, both within and between tomb contexts. The unburned material is composed¹¹⁸ of bone fragments that almost exclusively display solid cortices and primarily only none (Grade 0) to moderate (Grade 3) post-depositional surface alterations (Table 2) (McKinley *2004). No calcite deposits, which have been noted among human bones from megalithic tombs in England (see Barnatt and Edmonds *2002), were observed in the Carrowkeel assemblage. The bones display no clear evidence of bleaching or exfoliation due to exposure and weathering (see Behrensmeyer *1978), which is of particular interest in this context (see discussion below). Nor do the bones display any evident humus soil stains, suggesting that they had been surface depositions

¹¹⁷ I believe NISP belongs with the following phrase rather than this one, which pertains to the average weight. You are right.

¹¹⁸ “is composed of X” and “comprises X” are the options (your usage was correct in all the other cases)--OK as edited? OK You could also use “comprises bone fragments ...”

and had not been exhumed from the ground prior to being deposited in the chambers. Furthermore, only seven bone fragments displayed distinct marks of rodent gnawing (most likely caused by wood mice; see Haglund *1997), and there is no evidence of carnivore gnawing on any of the remains that might have indicated body exposure that¹¹⁹would have allowed for animal scavenging as part of the burial rite (see Smith *2006).
{table 2 here}

<a>Cremated Remains¹²⁰

<txt>The demographic profile of the individuals represented by the cremated material in the Carrowkeel assemblage has a higher proportion of non-adults and adult females compared to those represented in the unburned remains (see discussion in Geber et al. *2016), although this difference is not exclusive as unburned child and female remains are also present in the tombs.

The efficiency of the cremations and the consistency of the appearance of the Carrowkeel cremated bones suggest that a particular result was being sought in a careful and measured process. The predominantly pale cream-white color of the bones (see Table 3) indicates that they had been exposed to temperatures exceeding 800°C during the cremation and that they had been fully and completely incinerated (Ellingham et al. *2015; Ulguim *2015; Wahl *1982). This observation alone is significant, as it indicates that the physical end result of a cremation--in terms of the appearance of the cremated bones--was potentially just as important as whatever symbolic value was attached to the

¹¹⁹ Here's the first use of "excarnation" since the abstract, so I wonder if we need to address the definitional concerns here prior to using the term, or perhaps to use a different term, i.e., synonym. I think you are right. I've tried to rewrite it... I think double use of 'body/bodies' is superfluous here and I tried to make the phrasing clearer.

¹²⁰ This should be a subheading to 'Result', so need to be coded differently?

process (cf.¹²¹ McKinley *2008). The heat-induced cracks and fissures on the cortical bone surfaces were curvilinear and transverse in appearance, indicating that they are more likely to have been cremated while “fleshed” or “green” than while “dry” (see Baby *1954; Binford *1963; Buikstra and Swegle *1989; Thurman and Willmore *1981),¹²² although the reliability of using these features and patterns to determine pre-burning conditions of human bone has been questioned (see Gonçalves et al. *2015). The bones did not display any evidence of secondary staining (e.g., from soot and smoke, as described by Herrmann *1972), and this condition may suggest that they had been sorted and possibly cleaned (or even washed) before they were collected and interred in the tombs (see Gejvall *1961). This procedure is further indicated by a complete lack of pyre debris in the material (cf. O’Donnell *2016). The curated cremated bone samples from Carrowkeel comprise relatively large and well preserved¹²³ fragments. More than 90% of the weighed material comprises fragments measuring larger than 10 mm in size (Table 4). This proportion is a stark contrast to other prehistoric cremation burial samples elsewhere in Ireland, where fragments of the 10 mm size category have been observed in relative quantities of about 15% (e.g., Geber *2009). It is even higher in comparison with the degree of fragmentation reported from modern cremations, where between 43% and 71% of bones by weight comprise fragments measuring 10 mm in size or more (see McKinley *1993). {table 3 here} {table 4 here}

¹²¹ “cf.” is the abbreviation for the Latin *confer*, “compare”, so just one period.

¹²² Can’t use a semicolon here, since it would need to be followed by an independent clause.

¹²³ I’m not sure what “substantial” means here, if not “large”--is this a reference to the completeness of particular bones?

<a>Perimortem Cut Marks on Unburned Bone¹²⁴

<txt>The most significant discovery from the reassessment of the Carrowkeel assemblage was the presence of a minimum of 91 cut marks on 12 or possibly 13 unburned bones. These were not mentioned in Alexander Macalister's report, and it seems likely that he did not observe them during his analysis. Prior to this study, only two instances of dismemberment and/or defleshing with the use of lithic tools have been recorded from Neolithic burial sites in Ireland. In an unpublished account from the archaeological excavations undertaken at the Carrowmore megalithic complex in County Sligo during the 1990s, three bones from the same cranium (frontal, right temporal, and right zygomatic) from one monument (Tomb No. 51) displayed transverse cut marks that were interpreted as evidence of defleshing (Burenhult *1998:6, 18).² Another case was discovered during a reanalysis of human bones excavated from a megalithic tomb at Millin Bay in County Down in 1953, which consisted of an adult male mandible with clear cut marks across the right ramus and gonion (Murphy *2003). The new evidence from Carrowkeel presented here shows that this aspect of the Neolithic funerary rite, which has been frequently reported from numerous locations across Europe (e.g., Crozier *2016; During and Nilsson *1991; Núñez and Lidén *1997; Robb et al. *2015; Walsh et al. *2011), was also present in Ireland. It is a distinct possibility that a reexamination of bone assemblages from other excavations, especially those conducted in the earlier parts of the twentieth century or even before, could reveal further evidence of these practices that has thus far been overlooked. This evidence suggests that the people of Neolithic Ireland may have shared similar beliefs and ideologies concerning the treatment of the dead with communities beyond the Irish Sea.

¹²⁴ This should be a subheading to 'Result', so need to be coded differently?

The cut marks on the Carrowkeel bones were observed only on postcranial elements, which anatomically derived from a minimum of one adult individual of unknown sex. The bones in question were, however, present in at least two separate contexts (Cairns H and K). The cut marks were generally linear or very slightly curved shallow scores with an uneven V-shaped profile (cf. Greenfield *1999) located at or near the attachment sites for tendons and ligaments associated with the major joints of the body. The cut marks were identified as perimortem on the basis of the sharpness of the margins and a patination of the internal surface of the incisions, which corresponded to the surface condition elsewhere on each affected bone. The scores themselves displayed a uniform appearance, which is likely to indicate that they were all created using the same type of lithic tool, which for a northwest Irish Neolithic context is most likely either locally sourced chert (Bergh *2009), flint from Cretaceous geological deposits (Costa et al. *2005), or possibly even quartz (some fragments of which were found with the bone curated at the LCHES). No scrape marks were identified and, in combination with the anatomical location of the incisions, suggests that they were undertaken for the purpose of disarticulation and dismemberment rather than defleshing (Reichs *1998), although it cannot be ruled out that the latter occurred as part of this process. The disarticulation involved the shoulder, elbow, hip, knee, and ankle/foot joints. The absence of evidence elsewhere does not necessarily mean that other articulations were not involved, as the frequency of cut marks made by lithic tools on bones are likely to also have been dependent on the skill and experience of the person(s) who performed them (cf. Dewbury and Russell *2007). Radiocarbon dating of two of these bones indicated a date of circa 3500-3050 cal B.C. (Table 5). {table 5 here}

Disarticulation of a left and right shoulder was interpreted from two bones found in two separate contexts. A left first rib from Cairn H displayed multiple ($n > 18$)

coronal cuts across the attachment sites for musculature (e.g., the *scalenus medius* and/or *serratus anterior*¹²⁵) on the superior surface (Fig. 3a). The primary objective of the cuts, however, is likely to have been to sever the brachial plexus and thereby allow for the shoulder and upper limb to be ¹²⁶separated from the trunk. Additional¹²⁷ indirect evidence of shoulder disarticulation, which reveals a detailed understanding of the gross anatomy of the human body by the person(s) who undertook this procedure, can be interpreted from the presence of a minimum of 19 cuts running superoinferiorly across the dorsal surface of the right lamina of a cervical vertebra (from C3<n>C6) found in Cairn K (Fig. 3b). While these cuts may relate to an effort to disarticulate the head from the neck, it is more likely ¹²⁸that they were made in a procedure where the superficial and intermediate dorsal neck muscles (e.g., *trapezius*, *splenius capitis*, and *splenius cervicis*) and adjacent structures were severed in order to enable the *levator scapulae* and/or *rhomboid minor* muscles to be exposed so that the superomedial connection between the scapula and the neck could be separated. {figure 3 here}

A fragment of a left humerus recorded as being recovered from Cairn K displayed two or possibly three transverse cut marks across the anterior surface of the distal portion, just superior of the medial epicondyle (Fig. 4a). These incisions would have cut through

¹²⁵ The context indicates, I believe, that these are muscles. I'm removing "muscle" when the context makes that evident. Cf. "left femur" v. "left femur bone"

¹²⁶ "anatomically" seems redundant here--is there another way to separate them?

¹²⁷ The previous isn't "somewhat indirect evidence", correct? I suppose it is... The comma I added reads as "but" (and we could revise to say "similar but somewhat indirect"). If the previous was also "somewhat indirect", The previous was also 'somewhat indirect', so rephrase? How about simply; 'Further/Additional indirect evidence...'?

¹²⁸ An interpretation per se cannot be more or less *probable*--that's a function of its correctness.

the *pronator teres* and adjacent connective tissues, and thereby allowed for the bones to be exposed and separated at the joint. {figure 4 here}

Fragments from one left coxae¹²⁹ and a left and a right femur recovered from Cairn K, all possibly from the same individual, displayed multiple cut marks that are consistent with an intentional disarticulation of the hip joints. The coxae exhibited four oblique cut marks on the anterolateral surface of the iliac blade (Fig. 4b), which would have cut through the proximal attachments of the *gluteus minimus* and *gluteus medius*. The left femur displayed five or possibly six oblique cuts across the anterior surface of the shaft, just inferior of the greater trochanter. These are likely to have cut through the distal attachment of the *gluteus minimus*. At roughly the same level on this bone fragment, on the posterior surface, were four oblique cuts and one almost longitudinal cut on the proximal portion of the *linea aspera*, which would have cut through the distal attachment of the *gluteus maximus*. There were also two possible cuts, running at an oblique angle, on the anterior surface farther down toward the mid-shaft portion of this bone. These marks are more difficult to interpret but may relate to incisions through the *vastus lateralis*, which in that case may primarily relate to cutting through the superficial *tensor fascia lata*, which runs across the thigh at that location. If so, this procedure would have aided in exposing the hip joint and thereby allowed for the bones to be disarticulated.

The right femur displayed a transverse cut mark running across the anteromedial surface of the neck, which is likely to have been undertaken for the purpose of disconnecting the ischiofemoral ligament to enable the head of the femur to be pulled out of the acetabulum. There was also a shallow oblique cut running across the anterior surface just medial of the greater trochanter, which may have preceded the cut on the neck, as it would have enabled the bones to be exposed by cutting open the overlying

¹²⁹ Don't we need the singular form here? You are right.

muscle tissues at the anterior portion of the hip joint. This femur fragment also displayed five oblique and two transverse cuts at the quadrate tubercle on the posterior surface (Fig. 4c), that would have cut through the lateral attachment of the *quadratus femoris*, which connects to the ischial tuberosity.

The remaining 37 cuts identified in the Carrowkeel material were located on adult tarsal and metatarsal bones from an unknown context, and they all appear to relate to disarticulation of a left and right ankle joint (Fig. 5). The original context from which all these elements was found is uncertain, but the overall shape and size--and the reassociation of bones that was possible with many of these--would suggest that they are from the same individual and that they probably were all recovered from a single original context. One left calcaneus displayed a minimum of five axial cuts across the superior aspect of the lateral surface of the body that is likely to have cut through the distal attachment of the calcaneofibular ligament, and there were also two slightly oblique cuts running across the medial surface which would have involved the long tendon of the *flexor hallucis longus*. The latter structure, along with the tendon of the *tibialis posterior*, was most likely also cut through at the mid-tarsal level on the plantar surface of a left foot, as indicated from three parallel cuts on the plantar surface of a cuboid bone. {figure 5 here}

Another tarsal bone, a lateral cuneiform from a left foot, displayed one or possibly two cuts across the dorsal surface. This or these incisions would have cut through the long tendon of the *extensor digitorum longus*, among other structures, and would have severed the soft tissue connection between the distal phalanges and the leg. While the anteroposterior direction of the cuts in the sagittal plane may argue against that interpretation, they make functional sense when we consider that cutting through cadaveric tissue with a lithic blade most likely required a support base, as flaked stone

tools dull quickly, particularly during the process of disarticulation (Braun et al. *2008), and the bone itself was probably used as a base on which the tendon could have been placed and arranged so that it could have been cut through with more ease. The remaining cuts were all present on metatarsal bones. Longitudinal and oblique cuts were present on the shafts on the dorsal surface of all of these bones which are likely to have cut through the *extensor digitorum brevis* tendons, and also on the plantar surface of three bones which would have involved the *flexor digitorum brevis* tendons¹³⁰.

In addition to these cut marks was a possible--but uncertain--cut noted across the superior margin of the neck of a right adult rib from Cairn H. If this is in fact ¹³¹an incision from a lithic blade, it is likely to have originated either from a cut through the costotransverse ligament or from a procedure where the vertebral attachments of the tendons of the back muscles (e.g., *trapezius*) were cut through. In the latter case, this incision would then have enabled the shoulder to be disconnected from the trunk.

<a>Fragmentation of Bone¹³²

<txt>In their description of one of the tombs (Cairn F), Macalister et al. (1912:326) mentioned that some bones (described as “bone dust”) were found to be “much trampled” on the floor. It is apparent, however, that the bone material they described as bone dust is not part of the collection curated by the LCHES or the NMI. The degree of fragmentation of the human bone material that has been assessed appears to conform to a general pattern: the samples that included the smallest fragments of cremated bone also included

¹³⁰ singular “tendon” here but plural “tendons” earlier--OK? It should be tendons, as is refers to several (plural)

¹³¹ OK? You’re right! I’m not sure what a “true incision” would be--could we have a “false incision”?

¹³² This should be a subheading to ‘Result’, so need to be coded differently?

the smallest fragments of unburned bones, and vice versa. Whether this pattern signifies an aspect of the rite that was spatially manifested within the Carrowkeel complex deserves consideration but is difficult to ascertain, as it is unclear to what degree the curated samples from the 1911 excavation represent a bias toward larger fragments. Macalister et al.'s (1912:328-329) description of the cairns vis-à-vis the levels of prehistoric structural damage or collapse--for instance, the collapse of the passage at Cairn H --could not account for the degree of fragmentation of cremated bone present at different sites across the complex.

The most noticeable and highest degree of bone fragmentation was observed in samples from Cairn B, which stands out as a clear outlier in comparison with other tombs--for the unburned bone in particular. Of the cremated samples, the ¹³³least-fragmented material was recovered from Cairns H and K (see Table 4); and of the unburned samples, the least-fragmented bones were present in Cairns K and E (see Table 2). The significance of these differences (and similarities) between tomb contexts is difficult to determine. The large fragments of the cremated bone would imply that intentional crushing and pounding of remains after a cremation (see Lisowski *1968; Sigvallius *1994) is unlikely to have been part of the funerary rite at Carrowkeel--or at least that it did not involve the bones that were deposited in the tombs.

The fragmentation of the unburned bone, however, is unexpected considering the excellent state of preservation of these remains. Among these samples, only one humerus, two radii, and one ulna were complete among the major long bones in adult remains. The remainder (including femora, tibiae, fibulae, and fragmented portions of humeri, radii, and ulnae) were all fragmented. Nearly 70% (114/165) of all fragments from these long

¹³³ "least fragments" is susceptible to two different readings here: I believe you mean that these fragments showed the lowest *degree* of fragmentation, rather than the lowest number of bones (i.e., the *fewest*). Correct? Correct. The hyphen forces the first reading.

bones comprised less than half of the element, and it is evident that these fragments comprised primarily the shaft portions of these bones. The least relative fragmentation was observed in the smaller tubular bones, such as the metacarpals, metatarsals^{BB} and phalanges and other elements such as tarsals and vertebrae (see Fig. 6). Considering that the latter bones would be generally more fragile than primarily compact skeletal elements such as crania and long bones, it¹³⁴ is likely that fragmentation of the unburned remains was, to a certain extent, a *pars pro toto* component of the overall burial practice. The fragmented bones all displayed typically “dry” or “mineralized” bone fracture patterns, with perpendicular transverse or splintered uneven fracture margins, rather than helical oblique patterns with a smooth fracture surface textures expected from “fleshed” or “green” bone (Outram *2001; Outram et al. *2005), which indicate that these alterations occurred postmortem. {figure 6 here}

<a>The Funerary Rites at Carrowkeel: Processing the Dead

<txt>A complex and widely diverse set of funerary rites is¹³⁵ characteristic of burial practices in the Neolithic across Europe. The reasons for the diversity of burial practice have long been discussed in the archaeological literature. Sometimes a chronological explanation is proffered, but divergent forms of “burial” are often found within the same monument and in some cases have been demonstrated to be of similar age. Most commonly, diversity has been interpreted as an expression of social stratification (e.g.,

¹³⁴ In the original version of this sentence, “it” lacked a referent and couldn’t “suggest” something.

^{BB}I assume you mean metatarsal bones here. Metapodial is used in zooarchaeology but not in human osteology, at least in American practice. I’ve used ‘metapodial’ as a collective term for metacarpal and metatarsal, but spelled it out in the text now...

¹³⁵ or “Complex and widely diverse funerary rites are ...” if you prefer.

Binford *1972; Brown *1981). However, this diversity can also be viewed merely as a mortuary variation, which in fact is a rule rather than an exception in most cultures throughout history, including those of today (see Larsson *2003), and hence does not necessarily correlate with status. The manner in which corpses were processed and handled may be less important than the actual physical interaction between the dead and the living. The fact that burial practices involved a secondary stage does indicate that interaction or interrelation with the deceased was particularly important. It can be viewed¹³⁶ as a manner in which the living were able to physically aid the dead in reaching their next transitional stage. At Carrowkeel, complex and varied interactions with the dead are attested through choices made by the living that resulted in the cremation, dismemberment, or fragmentation of the bones of the dead.

The ideological background for the intended physical destruction (or perhaps better described as “de-construction”) of the body through fire, stone tools, or natural decomposition has often been discussed as a reflection of a dualistic religious concept in which people transitioned into different realms of consciousness after death (Lewis-Williams and Pearce *2005; Midgley *2010). The processing of bodies could, therefore, be interpreted as a way to aid the deceased, or rather their non-material selves, in the transition to a ¹³⁷state of postmortem existence. The bodies of the deceased being brought to the passage tomb complex could be seen as an important first milestone on that journey, a place of introduction to the land of the dead. In addition, the practice may have helped the survivors come to terms with their loss. Goss and Klass (*1997) have discussed four methods of contemporary Tibetan death rituals--sky rituals (exposure), cremation, ground burial (inhumation), and water burial--as different means for the dead to transition to

¹³⁶ OK? “perceived” seems passive here, whereas “viewed” involves intentional, constructive perception. OK

¹³⁷ The first, not a further one, correct? Correct.

other states. These postmortem journeys involve a transference of consciousness, which is aided and facilitated by the surviving relatives and the living community who perform these rites. By facilitating these transitions, the living are not only performing a “final act of compassion” for the dead but also resolving their own grief.

<a>Transition through Fire¹³⁸

<txt>The process of cremation is a process of transformation, and it is easy to understand how the fire and the heat that engulf the corpse, and the smoke it generates (both its smell and visual effect), could have been viewed as a physical transitional event in which the soul or spirit of the dead person was finally released from its physical boundaries (see Gräslund *1994; Nilsson Stutz and Kuijt *2014; Oestigaard *2005; Thompson *2015). The transformation is also materialist in terms of how the skeletal remains change form through cremation--after the flesh and soft tissue have been consumed by the fire, the bones of the skeleton fragment, distort, shrink, change color, and become more dense and brittle (Buikstra and Swegle *1989; Ellingham et al. *2015; Iregren and Jonsson *1973; McCutcheon *1992; Shipman et al. *1984; Walker et al. *2008). This alteration is, however, only apparent in fully incinerated and completely cremated remains where all organic components of bones have been destroyed and fusion of bone mineral has occurred (Ellingham et al. *2015; Iregren and Jonsson *1973); if only charred and burned, bones keep their shape and appearance, with the exception of black and sooty patches observed on the surfaces. To make sense of these processes and their end results, and to understand their significance, it is important to make a clear distinction between cremation and cremation burial or deposit. These terms are not synonymous; cremation

¹³⁸ This should be a subheading to ‘The Funerary Rites at Carrowkeel: Processing the Dead’, so coded differently?

relates to the process of burning/cremating a corpse on a pyre, while a cremation burial or deposit is the interred or placed material of the cremated remains (McKinley *2000; Thompson *2009). These two distinctive “phases” within the funerary rite would have held different symbolic meaning and significance, and therefore require clear differentiation when being discussed and interpreted (see Quinn et al. *2014).

When discussing the significance of cremation in prehistory, it is important to consider the practical aspects of the rite. A cremation would have required a lot of communal investment, not only in terms of resources but also with regard to labor. McKinley (*2008) has estimated that 700-900 kg of fuel would have been required to complete a cremation of an adult corpse in prehistory. In addition to the time required to construct a pyre, the procedure in which the cremation was prepared, maintained, and, eventually, the bones¹³⁹ collected after it had been completed would have taken numerous hours, possibly even days (Holck *1997; McKinley *2006). A cremation would also have been a highly visual manifestation; depending on where the cremation took place, it may have been visible for miles. It is currently not known where the cremations at Carrowkeel took place. No indications of pyre sites or cremation trenches were discovered during previous excavations at the complex--which seemed to be the case at Fourknocks II (Hartnett *1971). However, even with modern excavation techniques, low archaeological visibility could mean that pyre sites might not be found (Arcini *2005; Gräslund *1975; McKinley *1997).

<a>Depriving the Body of Flesh¹⁴⁰

¹³⁹ Would bones have necessarily remained? Yes (they always do – the ‘cremation dust/ashes’ is a myth – in cremations today, the bones? are ground into a powder)

¹⁴⁰ This should be a subheading to ‘The Funerary Rites at Carrowkeel: Processing the Dead’, so coded differently?

<txt>Witnessing the dismemberment of human remains as a ritual practice would have been a very different experience from attending a cremation. Those in attendance would have observed specialist(s) carrying out physical work that involved blood, secretions, smells, and intimate contact with the corpses. The detail shown by the examination of the bones suggests a daytime activity, and not one easily witnessed by large crowds unless intentionally staged. The evidence of dismemberment, as indicated from the location of the perimortem cut marks on bones, suggests that excarnation was part of the burial practice at Carrowkeel. This procedure has commonly been suggested to have been an integral part of the Neolithic funerary rite (e.g., Dowd *2008; Renfrew *1979; Smith *2006), but the term *excarnation* has not been¹⁴¹ used in a consistent manner and therefore has come to entail different meanings in the literature. For example, Reilly defined *excarnation* as the process of “burying the corpse in a temporary grave or exposing it to the elements until only a skeleton remained” (*2003:135), while Dowd defined it as a procedure where “the corpse is exposed and the flesh decomposes naturally, leaving a dry skeleton” (*2008:309). Etymologically, however, the term relates to the exposing the bones from covering soft tissues, deriving from the Latin *excarnāre*, meaning “deprive of flesh” (Oxford English Dictionary *2016). To explain the processes relating to some of the aforementioned definitions, the term *exposure* has been used (e.g., Harris *2010; Knüsel and Robb *2016), which in many cases would be more accurate.

When attempting to interpret the burial rite at Carrowkeel, the use of an accurate definition of *excarnation* provides a significant aid. While cremated and unburned bone derive from two distinctly different mortuary practices, in the context of excarnation, and following the true meaning of the word, they achieve a degree of commonality. In that sense, cremation and skeletonizing of bodies can be viewed as potentially equally

¹⁴¹ The term, not its definition, is used.

accepted modes of depriving the body of flesh and impute that this was done primarily for symbolic reasons rather than for the process of cremation, inhumation, and/or exposure alone. At Carrowkeel, removal of flesh was achieved by cremation as well as by leaving bodies (or perhaps only body parts) to decompose naturally. In support of the latter scenario, the unburned bone material shows a lack of evident surface staining as well as well-preserved cancellous bone portions and elements (e.g., epiphyseal ends of long bones and vertebrae). This condition suggests that bones had not been inhumed (see discussion below) or exposed to the elements during the process of decomposition (Galloway *1997).

The uniform appearance of the bone assemblage from Carrowkeel, and indeed the distinct pattern of anatomical precision in relation to where cut marks were located on bones, indicate that the specific process through which these transitions were achieved had a significant role as well. This process most likely also included the physical act of bringing the human remains to the passage tombs themselves (cf. Appleby *2013; Oestigaard *1999) and the deposition of the skeletal materials in the chambers and passages. These processes, when practiced within the ceremonies of the funerary rite, would have provided opportunities to maintain or create new social bonds within and between societies (see Tilley *1996). As such, the importance of the rites would have encompassed much more than achieving the requisites and expectations of the communal religious beliefs and cult praxis.

<a>Processing Bodies through Fragmentation¹⁴²

¹⁴² This should be a subheading to ‘The Funerary Rites at Carrowkeel: Processing the Dead’, so coded differently?

<txt>The evident fragmentation of human remains in the Carrowkeel passage tombs, either by cremation, dismemberment, and potentially further postmortem processing, may be an attempt to homogenize the bone material and form a coherent physical representation of the dead that would no longer be represented by a body or corpse. Fragmentation of human remains as an integrated anthropogenic component in the Neolithic burial rite has also been suggested in a recent taphonomic study of funerary deposits from Orkney (Crozier *2016). Crozier's study identified not only evidence of dismemberment and defleshing but also intentional breaking of bones by stone tools, as indicated by the presence of percussion pits. No such evidence was observed in the remains from Carrowkeel, but the fracture pattern of the unburned bone--and indeed the protected structural context in which they were found--suggests that postmortem breakage of the bones was considered a part of the rite.

On a more holistic level, this fragmentation of the dead may be viewed as an expression of a broader paradigm that has been suggested for Neolithic societies. The evident intentional fragmentation and destruction that is often observed in the case of the material culture have been suggested to represent modes of "enchainment" between people and their environs, and that the rituals and processes during which they were made enabled social unifications and identities to be formed (Chapman *2000; Larsson *2015). When taking this idea into consideration, the rites and procedures involved in the act of processing the dead at Carrowkeel may therefore have helped the dead in their transitions to other realms and also functioned as important social constructs for the living community and people who performed them.

<a>Contextualizing the Mortuary Rite at Carrowkeel

<txt>The human remains from Carrowkeel reveal diversity in secondary funerary practices, something that may have been of particular importance to the community or communities who constructed and used the monuments. The fact that a significant proportion of the human bone material from Carrowkeel comprised unburned bones is noteworthy because cremation is generally the predominant funerary rite associated with passage tombs excavated elsewhere on the island (Cooney *2014; Cooney and Grogan *1994; Dowd *2015). Cremation also seems to have been the prevalent funerary rite in the Irish Neolithic overall, occurring in nearly 60% of all burials known to date (Murphy et al. *2010). The presence of significant amounts of both cremated and unburned bones indicates that diverse funerary rites were integral to the use of these monuments, although the original significance of these is difficult to ascertain. When considering the relative representation of individual skeletal elements between the cremated and unburned material, there was no substantial difference between these samples (see Geber et al. *2016), suggesting that there was not a specific selection of body parts used for either rite.

The choice between cremation and non-cremation in prehistory has traditionally been interpreted as manifesting adherence to social practices, that is, that the rites had different symbolic meanings and roles (Rebay-Salisbury *2012). Cooney discusses inhumation (he uses the term to include surface depositions of unburned bone in megalithic tombs, which are technically not “inhumed” in the strict meaning of the word) and cremation as distinctly different but contemporaneous mortuary rites in the Irish Neolithic, and he argues that unburned and cremated bones had different symbolic connotations that were spatially manifested in the manner in which they were deposited both within and in the perimeters of megalithic monuments (Cooney *2014).¹⁴³The

¹⁴³ Perhaps put the following in an endnote instead? That’s a common approach to this sort of aside. That would work

chronological relationship between the cremated and unburned human bone deposits at Carrowkeel will be discussed by the authors¹⁴⁴ for a forthcoming paper.¹⁴⁵

The original spatial distribution of cremated and unburned bones inside the Carrowkeel tombs is largely unclear. Unfortunately, the original excavation and analysis of the remains from 1911 have contributed to a deterioration of the archaeological record, as many of the remains have been mixed and the original context and stratigraphy of a substantial proportion of the material cannot be ascertained (see Geber et al. *2016; Hensey et al. *2014). The infrequent direct references to the location of the bones in the 1912 publication only state in general terms that they were found in the main chambers and recesses of the tombs (Macalister et al. *1912), though more specific locational information is in certain instances alluded to in Alexander Macalister's handwritten notes found with the bone assemblage at the LCHES. The quantitative and demographic analysis of the remains (see Geber et al. *2016) can discern potential but only tentative contextual disparities in relation to the physical build and sex of the individuals interred in the monuments. Although the picture is unclear, the tombs may have had different social functions.

The taphonomic analysis in this study appears to single out Cairn B as an outlier in relation to the other contexts; this tomb included a higher proportion of more-fragmented bones in both the cremated and unburned samples. Other potentially disparate tombs were Cairns H and K, which were not only the monuments that included bones with evidence of dismemberment but also contained the least-fragmented bone samples. While there is an overall uniformity of the condition and appearance of the human remains from the various tombs at Carrowkeel, these subtle taphonomic differences may

¹⁴⁴ By whom? Cooney? By us (the authors of this paper)

¹⁴⁵ When? It is work in progress, we have no idea when the paper will be published.

be indications of variability in the funerary rite that was expressed spatially within the complex, which may relate to the architectural variation of the passage tombs themselves (Hensey 2015:144-147; Macalister et al. 1912). This variation may therefore be interpreted in a similar manner as Cooney's (2014) reading of the spatial patterning of cremated and unburned bone depositions at Irish megalithic tombs. The bones may have incorporated a symbolic meaning relating to communal identity that defined both the use of the monuments and how they were socially perceived in the landscape itself. The manner in which they were deposited in the passage tombs following processing could have been one of the most significant aspects of the burial rite.

The passage tombs of the Neolithic have sometimes been interpreted as architectural imitations of caves that also served a mortuary purpose (Dowd 2015; Lewis-Williams and Pearce 2005), and that the construction of these monuments manifested not only social presence in the landscape but also a certain degree of control of access and connection to the realm of the dead. Dowd (2015) has argued that caves performed a particular mortuary function in Neolithic Ireland as excarnation places with, in some instances, the bones later being deposited in megalithic monuments. If so, the use of passage tombs as structures in which bodies (or perhaps only body parts) underwent similar processes of excarnation and fragmentation appears plausible. In contrast to caves, however, the majority of the bones would then remain at the location where they were excarnated. It should be noted that the recent discoveries of probable excarnation practices from Cave K near Queen Maeve's tomb on Knocknarea Mountain, only 25 km north of Carrowkeel and within 1 km of the passage tombs on the mountain summit, may have a bearing on this discussion (Dowd and Kahlert 2014). Though Neolithic bone has not been found in the extensive Kesh Caves or the seven additional caves found in the

vicinity of the Carrowkeel complex, it cannot be ruled out that similar practices occurred there.

<a>Conclusion

<txt>Alexander Macalister's analysis of the Carrowkeel bones in 1911 stands up well to modern scrutiny when taking his estimations of the minimum number of individuals and his metrical analysis into account (Geber et al. *2016). His study was a product of its time, which placed a particular focus on craniology and metric analysis. To include new methods from the evolving discipline of bioarchaeology and its precursors--in particular, the advent of taphonomic analyses of bone--was a focus of the current reassessment of the Carrowkeel material. This study has highlighted that many old curated collections of previously studied archaeological bone may still have considerable scientific potential, which has been shown from many reassessments of Neolithic samples in particular (e.g., Crozier *2016; Walsh et al. *2011).

In the case of Carrowkeel, the reanalysis of the assemblage has highlighted the high level of complexity and diversity of the funerary rites, which perhaps was not fully recognized previously. This complexity is particularly evident in the manner in which the bodies of the deceased were processed and handled after death. This treatment included cremation, dismemberment, and possibly intentional fragmentation of remains. The evidence of postmortem body processing at Carrowkeel is not unique from a European perspective, but it remains a rarely reported occurrence from the bioarchaeological record from Ireland. This discovery provides another key to understanding the social significance of this fascinating cultural and ritual landscape for the people who constructed and used it over several centuries, five thousand years ago.

<a>Acknowledgments

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<a>Notes

- <nt>1. The calculation of MNE values considered crania as complete units, and because many of these were in articulation, quantification of number of elements for individual cranial bones was not undertaken..
2. This specimen has been radiocarbon dated to circa 3500 cal B.C. (4625 ± 60 B.P.) (Ua-11581).

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¹⁴⁷ Journal style is to use “sentence-style” capitalization for article titles and “headline” style for book titles (in italics). Please note any oversights. Does not apply to German titles.

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¹⁴⁸ Can we update? It is still early view, I'm afraid...

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