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Tinkering with the dead: taphonomic analysis of human remains from Tinkinswood chambered tomb, Wales

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Tinkinswood chambered Neolithic tomb in the Vale of Glamorgan, Wales, was originally excavated in 1914 and the human remains found within were analysed by the renowned anatomist Sir Arthur Keith. Further excavation has recently been carried out in the surrounding landscape and the monument itself has been the focus of community archaeology and outreach projects. These works attest to the continued archaeological importance of the site in its local area, yet the results of Keith's work remain cited a century later. Considering the recent initiative to re-analyse many Neolithic skeletal assemblages, this study presents the results of a new taphonomic assessment of the human skeletal material, significantly revising earlier interpretations. The estimated minimum number of individuals (MNI) represented in the assemblage is reduced, more closely corresponding with recent results obtained at other contemporary monuments. Analysis of post-depositional modification suggests remains were not manipulated during the perimortem interval. The relative representation of skeletal elements indicates that selected long bones were removed from the tomb, revealing a complex and prolonged process of engaging with the dead.

INTRODUCTION

The British Neolithic (*c.* 4100–2200 BC) is notable for its long tradition of monument building, including complex structures built to house the remains of the dead. Early Neolithic funerary monuments took varied forms, including earthen long barrows, megalithic chambered tombs, passage tombs and portal dolmens, while non-monumental burial in caves, enclosures and pits is also attested to. Historically, the commingled and fragmented human remains found within Neolithic monuments were overlooked and significant research was instead directed towards monument construction and typology (e.g. Corcoran 1969; Crawford 1925; Thurnam 1868). For the past two decades, however, there has been a renewed interest in reconstructing Neolithic lifeways and deathways through the analysis of skeletal remains. The introduction of taphonomic methods to bioarchaeology, commonly used in the analysis of archaeological faunal assemblages, has increased the analytical potential of fragmented human remains (Knüsel and Robb 2016). Re-analysis of skeletal material from many British Neolithic funerary sites has been instrumental for informing archaeological understanding of the demographic represented within monuments, the timing of their use, and the wide range of funerary practices performed in this period (Beckett 2011; Crozier 2018; Smith and Brickley 2009; Whittle and Wysocki 1998; Wysocki and Whittle 2000; Wysocki *et al.* 2013).

Taphonomic analysis has highlighted the wide range of possible ways to treat the dead in early Neolithic Britain. Antiquarian interpretations predominantly reported that fragmented human remains were the result of secondary reburial, with tombs used as ossuaries (Rolleston 1876, 137; Crawford 1925, 13). Recent works incorporating careful taphonomic analysis have produced a more nuanced picture of early Neolithic funerary practices, demonstrating that while corpses were often deposited whole within funerary monuments, multiple practices are represented at many sites (Beckett and Robb 2006; Crozier 2018;

Smith and Brickley 2009; Whittle *et al.* 2007). The process of successive deposition of the dead, alongside natural (such as diagenesis and weathering) and cultural (including the rearrangement and redistribution of remains) post-depositional processes are responsible in many cases for the fragmented assemblages we are presented with today (Beckett and Robb 2006; Robb 2016). Recent studies have highlighted variations in funerary treatment both within and between sites. For example, at Adlestrop and Parc le Breos Cwm, some corpses were exposed to scavengers (Smith 2006; Whittle and Wysocki 1998); select remains were defleshed prior to their interment at West Tump and Coldrum (Smith and Brickley 2004; Wysocki *et al.* 2013); at Quanterness, as well as cutmarks, there is evidence for the deliberate fragmentation of remains (Crozier 2016, 2018). In addition to these practices of directly processing the corpse, it is increasingly acknowledged that cremation was widespread during the early Neolithic (McKinley 2008; Smith and Brickley 2009). The diversity of ways in which the dead were treated reveals complex understandings of the process of death. Funerary practices may have responded to a range of factors, including aspects of an individual's identity and life course, as well as the timing and circumstances of their death (Robb 2007). The picture from early Neolithic monuments suggests that communities held distinct ways of engaging with the dead which, while differing locally, form part of a broader cohesive suite of practices (Beckett and Robb 2006; Crozier 2018). These practices also relate to wider understandings of the body beyond the sphere of funerary rites, as discussed below.

Despite this growing body of work, relatively little is known about depositional practices at Tinkinswood. Although small in size, Tinkinswood is a prime example of a single chambered Cotswold-Severn tomb and is thought to possess the largest megalithic capstone in Britain (Cadw 2016). More than a century has passed since its excavation and publication by John Ward (1915, 1916) and since the original analysis of the human remains by Sir Arthur Keith (1916). Keith provided a preliminary taphonomic analysis of the assemblage and estimated that 50 individuals were interred in the tomb. This estimate of the minimum number of individuals (MNI) has been quoted in all subsequent research. Most recently, Tinkinswood has been the focus of a number of outreach projects, including community excavation and public open days, reinforcing the significance of the monument and its impact on the local community

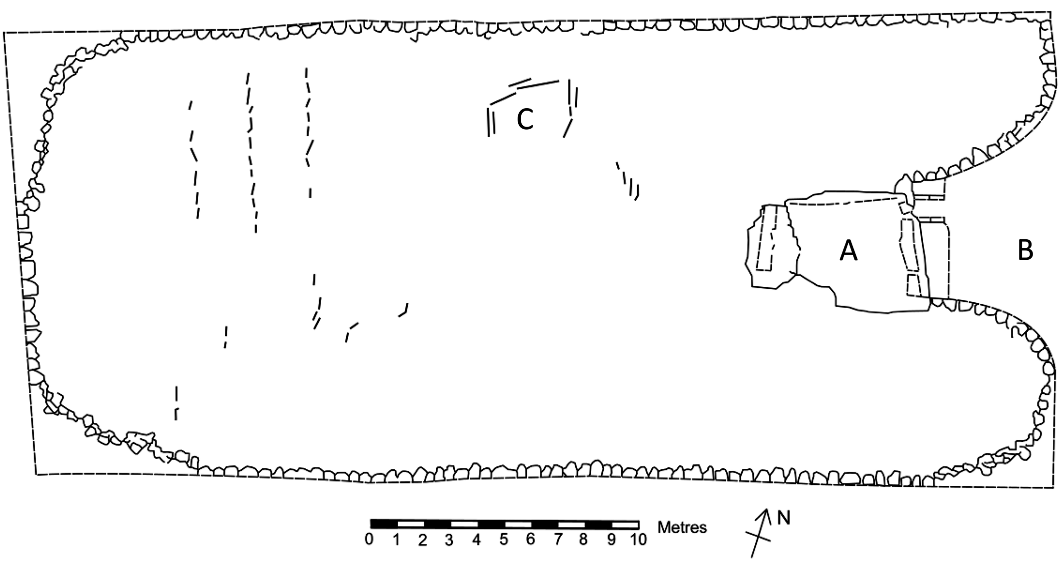

Fig. 1. Plan of Tinkinswood, A – chamber; B – forecourt; C – cist (redrawn from Ward 1915, 295).

in the present (Pannett 2012; Reynolds 2014; Reynolds and Adams 2014). An updated assessment of the Tinkinswood material is therefore timely and necessary. A full bioarchaeological assessment of the human remains fell outside of the scope of this project. This paper reports the results of a taphonomic analysis of the assemblage, with the aim of updating our understanding of the burial population and funerary practices.

ARCHAEOLOGICAL CONTEXT

The early Neolithic in southern Britain is generally accepted to begin around 4100 cal. BC (Whittle *et al.* 2011, 800), although it has been argued that earlier origins can be identified from ceramics and tomb forms with Continental parallels dating to the late 5th millennium BC (Sheridan 2004; 2007; 2010). The construction of monuments did not begin until a century or more after the introduction of Neolithic practices in each region. The earliest construction of funerary monuments in Britain is largely dated to the 38th century cal. BC (Whittle 2007, 382; Whittle *et al.* 2007), although Coldrum, Kent (3980–3800 cal. BC, 95% probability) and Broadsands, Devon (4121–3712 cal. BC, 95% probability) provide some isolated earlier dates for this phenomenon (Sheridan *et al.* 2008; Wysocki *et al.* 2013). Bayesian modelling of radiocarbon dates from five funerary monuments suggests that on average they were in use for 3–5 generations, with an estimation of 25 years per generation (Whittle *et al.* 2007). These studies show that collective burial was a distinctive early Neolithic practice and monument use was often short-lived. This calls into question the extent to which collective burial during this time can be attributed to practices of honouring the ancestors.

Tinkinswood belongs to the Cotswold-Severn group of monuments distributed across the uplands of Gloucestershire, North Oxfordshire, North Wiltshire, Avon, Somerset and South Wales (Corcoran 1969). Approximately 200 monuments have been identified within this group, although at least ten have been lost since they were originally recorded (Darvill 2004, 83). Based upon their morphology and the location of chambers, Cotswold-Severn tombs are traditionally divided into four types: those with a single or multiple chambers entered through a corridor at the widest part of the cairn (known as 'simple terminal' or 'transepted terminal' types respectively), those with chambers accessed from the side of the monument (lateral), or hybrid forms of these (Corcoran 1969, 14). Tinkinswood is a simple terminal tomb, containing one burial chamber at the widest end of the cairn. Similarities have been drawn between Tinkinswood and a number of other Welsh monuments which, due to their form and coastal setting, may represent a hybrid monumental form drawing upon both portal dolmen and chambered tomb traditions (Cummings and Whittle 2004, 68).

Current chronologies illustrate that the lateral chambered tombs at Ascott-under-Wychwood and Hazleton were in use from the beginning of this period of monumental construction (Bayliss, Benson, *et al.* 2007; Meadows *et al.* 2007). Radiocarbon dates from four fragments of human bone from Tinkinswood indicate that it was already in use by *c.* 3700 cal. BC (OxA-11406-9), situating its construction early within this chronological framework (Cummings and Whittle 2004, 59). A similarly early date (3760–3645 cal. BC) has been obtained for the construction and use of the single chambered tomb at Lambourn (Schulting 2000). These results have refined earlier hypotheses of a progression from 'simple' to 'complex' forms of funerary monuments (Darvill 1982, 77). While lateral chambered tombs may in general be the earliest form in the Cotswold region, there is some evidence to suggest a more mosaic pattern of monument construction.

Early Neolithic funerary practices

British Neolithic monuments have long been a touchstone for archaeological interpretation (e.g. Crawford 1925; Renfrew 1973; Thomas 1999; Thurnam 1868; Tilley 1996; Whittle 1996), but it is only relatively recently that archaeologists have begun to seriously engage with the social processes underlying funerary practices. Monumental collective burials have perhaps most commonly been cited as evidence for ancestral veneration, a practice seen as intrinsic to Neolithic ontologies across much of Europe and beyond (e.g. Parker Pearson and Ramilisonina 1998; Li 2000; Kuijt 2002; Stoddart and Malone 2015; Alt *et al.* 2016). In 4th millennium BC Britain, the widespread practice of collective burial and the manipulation of human remains has often been linked to an ideology of corporate ancestors (Barrett 1988, 1994; Bradley 1998; Shanks and Tilley 1982; Thomas 1999, 162). However, as Whitley (2002) notes, there are limited ethnographic parallels for such a model, and this enduring narrative has obscured attempts to understand the diverse relationships maintained with the past.

The heavily commingled and fragmented deposits in simple terminal tombs have been suggested to represent a deliberate fracturing of the integrity of the body, contrasting practices at lateral and transepted tombs (Thomas 1988; Thomas 1999, 150). This may be over-interpreting the evidence and failing to account for a number of factors which might explain this pattern, such as the disturbance of chamber contents prior to excavation, and the excavation of many sites without rigorous recording techniques. These practices obscured the visibility of discrete individuals and articulating regions of the skeleton, as well as complicating subsequent quantification efforts (e.g. the estimation of MNI) due to disturbed archaeological contexts. The careful excavation and recording of Hazleton North facilitated subsequent fragment conjoining, conclusively showing that the deposit of mostly disarticulated bone arose due to repeated disturbance of primary interments (Saville 1990).

Many single chambered tomb deposits attest to multiple means of treating the dead. For example, both inhumation and cremation has been identified at Milbarrow, Ffostyll North and Tinkinswood (Keith 1916; Vulliamy 1922; Whittle 1994). A similar mixture of funerary treatments is evident at lateral and transepted tombs, evidencing a range of funerary practices. Arguably, considering the evidence for disturbed primary inhumations at many sites, successive deposition was a common practice. This would have encompassed the interment of newly dead individuals into megalithic chambers which already contained human remains in various stages of decomposition and disarticulation. This process, alongside natural diagenesis and degradation of bone, results in highly fragmented remains (Beckett and Robb 2006; Robb 2016). It is possible that greater fragmentation was achieved in monuments with restricted space, compared to those where remains could be redistributed between chambers. When taphonomic factors are accounted for, it is difficult to maintain a distinction between tomb types based on depositional practices.

The variety of methods used to dispose of the dead were contextually dependent, differing both within and between monuments and regions. Rather than considering funerary practices in relation to tomb typology, asking how death was achieved socially through specific actions which engaged with the remains of the dead, may be more revealing of Neolithic ontologies (Robb 2013). In this view, it seems plausible that the performance of disarticulating and rearranging the dead was particularly integral to early Neolithic funerary rites. Evidence for the curation of older, disarticulated human remains is currently only known at Fussell's Lodge (Wysocki *et al.* 2007) and Burn Ground (Teather 2018), indicating the rare deposition of remains which may have been viewed as especially powerful or 'ancestral'. Teather's (2018) recent analysis of radiocarbon date outliers provides further evidence of such practices, identifying the widespread redeposition of ancient faunal remains (specifically deer and bovids) in Neolithic contexts. It is suggested that these remains may have been removed from caves as a form of cultural appropriation in which 'remnants of the past' were used to assert relationships with the land, particularly through animals with comparable social structures to humans (Teather 2018, 13). Neolithic bodies seem to have been cohesively understood through ontologies of partibility — in which the potential for separation of bodies and bones was exploited as a means to reconfigure the dead, create distributed relations, and sometimes to recombine parts of different individuals — and permeability — with decomposition initiating the flow of substances from the body (Fowler 2003, 2008; Harris 2018; Thomas 2002). Harris (2018), drawing on the use of materials and space in relation to bodies, reconfigures this as a large-scale dual ontology of 'parts and flows', in which the soft and hard tissues of the body were differently understood.

HISTORY OF EXCAVATION AND RESEARCH

Located in the Vale of Glamorgan, Tinkinswood is situated on sloped south-facing ground, surrounded by pasture and woodlands (Reynolds 2014). Tinkinswood is enclosed by a revetment wall, and the cairn would originally have been capped by an earthen and stone mound. A paved forecourt and short passage on the eastern side of the monument open on to the small burial chamber which is constructed of six large stone orthostats (Fig. 1). A slab lined cist is located within the cairn to the north of the monument. Recent interpretations have suggested the cist may have been used during the Bronze Age as a site for excarnation or place of secondary burial (Reynolds 2014; Reynolds and Adams 2014). Measuring at least 2 metres long, the Tinkinswood cist is larger than Bronze Age examples and similar in form to those found at nearby Penywyrlod (Talgarth) and Ty Isaf. Darvill (2004, 61) suggests the Tinkinswood cist represents the remains of a pre-cairn monument such as a round barrow or rotunda grave. Radiocarbon dates obtained from four human bones date the use of Tinkinswood to at least 3700 cal. BC (Cummings and Whittle 2004, 59), although it is not possible to ascertain the duration of the monument's use from so few dates.

Antiquarian interest in Tinkinswood began during the mid-1800s, when a human mandible was found at the site by the Revd H. Longueville Jones (Jones 1869, 187). The antiquarian J. W. Lukis (1875, 171) further explored the tomb; finding fragments of human teeth, unburnt bone and pottery sherds in the debris outside, he surmised that the chamber was robbed and the 'contents [were] thrown out years ago and no record of them kept'. In 1914, John Ward, the first keeper of archaeology at the National Museum of Wales, undertook excavation and reconstruction of Tinkinswood. Ward and his team found human remains in the forecourt, the passage, and within the chamber. In the forecourt, the human remains were excavated alongside nearly 100 sherds of coarse black pottery that had been smashed, suggesting ceremonial use of this area (Ward 1915, 306). Within the chamber, commingled human and animal remains were excavated from a 60cm-deep deposit (Ward 1916, 244). A slab-lined cist was discovered at the northern side of the cairn containing, and surrounded by, fragments of human and animal bone (Ward 1915, 311).

In addition to human remains, nearly 150 fragments of animal bone were recovered. These mostly represent Neolithic domesticates (cattle, sheep and pig), as well as wild species (horse, aurochs and deer) but some intruders of later date are also present, including pole cat, fox and rabbit (Ward 1916, 264–66). Alongside the human and animal bones, sherds of both coarse and fine pottery and several worked flint flakes, including a leaf shaped arrowhead, were excavated; only one or two of the flint flakes were deposited in the chamber (Ward 1916). Many of the ceramic sherds were excavated from the forecourt, and were suggested to have been ceremonially smashed as part of funerary rituals (Reynolds 2014, 177). Additional possible Neolithic artefacts include a bone pin, hammerstone, antler tine and antler die (Ward 1916). Beaker sherds and a whetstone were excavated from the chamber, indicating re-opening of the tomb in the Bronze Age. The Beaker is of All-Over-Ornamented type, representing one of the earliest found in Wales (Fitzpatrick 2011, 204). Romano-British pottery and medieval and post-medieval artefacts were found in the chamber, including an antler object, iron knife, copper alloy harness boss, and clay pipe as well as modern pottery and brick. These represent numerous later visits to the tomb, and some may be contemporary with the historic looting of the site.

During the excavation of Tinkinswood, it was noted that the monument was unstable; as a result, Ward and his team were primarily concerned with its reconstruction. The location of skeletal remains and artefacts within the chamber were unfortunately not recorded, and the soil was too clayey to sieve. Ward admits, in a footnote to Keith's discussion on the uneven preservation of skeletal elements, that many poorly preserved fragments of vertebrae and ribs were discarded (Keith 1916, 276, footnote 1). On this basis, it is likely that other small bones such as carpals, tarsals, phalanges, and loose teeth were also overlooked. Recent excavations at the nearby Bronze Age barrow identified some human remains that were not contemporary with the barrow's construction (Pannett 2012, 21). One tooth was dated to 3600 cal. BC, and analysis of the assemblage suggests that the remains of at least three individuals (from infant to adult in age), and possible further cremated remains, may have become incorporated in the monument due to Ward's spoil deposition (ibid.).

The remains present in the Tinkinswood assemblage today do not fully represent the original burial assemblage, due to the *in situ* destruction of bone through natural processes of degradation and cultural processes of successive burial, the disturbance of the chamber contents prior to excavation, and selective recovery methods. Furthermore, following excavation, the human and animal remains have become separated from their archaeological context. A lack of documentation means that it is not possible to distinguish between those found in the forecourt area, those surrounding the cist, and those from within the passage and chamber. This precludes analyses such as the spatial redistribution of remains throughout the monument, and also limits the ability to identify any potential differences in the material from the chamber and the cist, in order to resolve the debate surrounding the timing of the cist's use.

In Keith's original analysis of the human remains, he commented upon the extremely high level of breakage within the assemblage. From approximately 920 fragments, he estimated that a total of 40–50 individuals of all ages and both sexes were deposited within the tomb (Keith 1916). Some of his methodology for demographic profiling was inaccurate, however. The minimum number of individuals (MNI) is usually calculated from the most prevalent element in the assemblage, taking into account its frequency in the skeleton, and further allowing for determinations of age and sex (Mays 1998). Based largely upon robusticity, Keith attributed sex to many fragments and also often assigned small shaft fragments lacking identifiable features to side. It is probable that the total number of individuals originally given is an overestimation. Innovatively for his time, however, Keith (1916) described taphonomic alterations to the human bone. Eight very small cremated cranial fragments were identified, alongside two fragments of bone that were charred following skeletonisation. No evidence was found for cut or scrape marks, and a few signs of gnawing were attributed to rodents. Fractures were noted on both fresh and dry bone, and he sensibly suggested that the least fragmented bones were the remains of the latest burials.

More recently, the Tinkinswood remains were analysed as part of a large-scale study of early Neolithic assemblages in southern Britain. Published results from Tinkinswood mostly concern the analysis of musculoskeletal markers (or entheseal changes). The location and expression of entheseal changes were found to differ between females from Tinkinswood and West Kennet and males from Tinkinswood and Parc le Breos Cwm (Wysocki and Whittle 2000), suggesting gender-specific activity patterns or lifestyles within the local region (Whittle and Wysocki 1998). However, these analytical methods have since been substantially revised and there is potential for further work to refine these results (Jurmain *et al.* 2012). Analysis of cranial trauma across early Neolithic burial assemblages revealed two cases of healed blunt force trauma on adult male crania at Tinkinswood (Schulting and Wysocki 2005). This evidence is part of a wider pattern of conflict and interpersonal violence across this period, suggesting occasional small-scale attacks (Smith 2014). Samples from Tinkinswood human remains were also included in the recent aDNA (ancient DNA) analysis of the ancestry of early Neolithic British populations (Brace *et al.* 2018).

RE-ANALYSIS OF THE HUMAN REMAINS

As the human remains from Tinkinswood were not recorded *in situ* during excavation, there is no associated spatial and contextual information. Critically, no detail regarding the association of elements or articulating bone groups is available. It was therefore not possible to identify any first order articulations in the laboratory.

Methods

Each bone fragment was identified, when possible, to skeletal element and side and examined macroscopically for a range of taphonomic processes including weathering, root damage, animal gnawing, cutmarks, burning, and breakage. The completeness of each fragment was quantified to assess the extent of fragmentation (Bello 2005). The colour of charred or cremated bone fragments was described, following recommendations in McKinley (2004a) to assess the degree of oxidation. The characteristics of fractures to long bone, specifically fracture angle, outline and texture, were analysed and recorded as either 'perimortem', 'dry' or 'recent' following criteria within Knüsel (2005), Outram (2002) and Wieberg and Wescott (2008). While fresh ('perimortem') bone still holds much of its original collagen content; this lends it plasticity in response to breakage and typically results in spiral or helical fractures with a smooth texture to the fracture margin (Knüsel 2005). Breakage to bone which retains either some or no collagen is typically termed 'dry'. Fractures to dry bone tend to produce transverse or stepped outlines, with rougher fracture margins.

The assemblage was quantified and a minimum number of individuals (MNI) reached by first calculating a minimum number of elements (MNE) for each skeletal element for both adults and nonadults. The MNE was calculated for all major skeletal elements and regions, accounting for side. For long bones, epiphyses and diaphyses were recorded as present or absent, and the major regions of cranial elements and elements of the axial skeleton were recorded as present or absent. As the femur was the most prevalent long bone in the assemblage, each femoral fragment was inventoried using a zonation method; this method divides the femur into eleven regions, each with recognisable anatomical features (Knüsel and Outram 2004). Ideally, all elements would have been inventoried according to this method, but due to time constraints, this was unfortunately not possible. MNI was generated from the skeletal elements which produced the highest adult and nonadult MNE, respectively. These calculations are then used to analyse the relative representation of skeletal elements, with each element expressed as a proportion of the estimated MNI. Skeletal element representation can be used to examine funerary practices according to expectations regarding the preservation of elements in different scenarios (Robb 2016, 690). Element representation is calculated using the formula for the bone representation index (BRI) devised by Dodson and Wexlar (1979), where:

$$\text{BRI} = (\text{MNE})/(\text{number of elements in a complete skeleton} \times \text{MNI}) \times 100$$

In the case of elements which only occur once in the skeleton (e.g. mandible, sternum, sacrum), the MNE can be directly divided by the MNI. For paired elements, or regions of bones (e.g. carpals/tarsals, metacarpals/metatarsals and phalanges), the total number of bones in each region per individual is multiplied by the MNI. For example, there are 5 lumbar vertebrae in each body, and if 12 lumbar vertebrae are present in an assemblage containing 20 individuals, the MNE of 12 would need to be divided by 100, providing a bone representation index (BRI) of 12%. This method has been critiqued for implying that all elements should ideally be equally represented. This assumption does not account for taphonomic factors which can bias the preservation of specific types of bones (Robb 2016, 692). However, it provides a useful means of inter-site analysis both in terms of investigating cultural practices, as well as exploring the relationship between skeletal element representation, the length of site use, and environmental conditions.

Sex was determined from cranial and pelvic morphology following Buikstra and Ubelaker (1994). It was not possible to assess all diagnostic features of either the cranium or pelvis (*os coxae*) on any individual specimen due to the extent of fragmentation, rendering results uncertain. Adult age estimates were obtained through analysis of dental attrition (Brothwell 1981) and pubic symphyseal morphology (Brooks and Suchey 1990). Age in juveniles was estimated through dental eruption (AlQahtani *et al.* 2010) and epiphyseal fusion stages (Schaefer *et al.* 2009). Nonadult long bones were frequently too fragmented for diaphyseal length measurements to be taken. Age categories were used as follows: nonadult individuals were subdivided into infant (0–3 years old), child (3–12 years old), and adolescent (12–20 years old) categories, while adults were classified as 'young' (20–35 years old), 'middle' (35–50 years old) or 'old' (50+ years old) (White *et al.* 2012, 385).

Taphonomy

The assemblage comprises 947 fragments of human bone and loose teeth. Some elements were reconstructed from multiple fragments by Keith, and in this case the original fragments have not been counted individually. Overall, the preservation of cortical surfaces is fair, but element representation is affected by high fragmentation, abrasion, and trabecular erosion (McKinley 2004b). Figure 2 represents

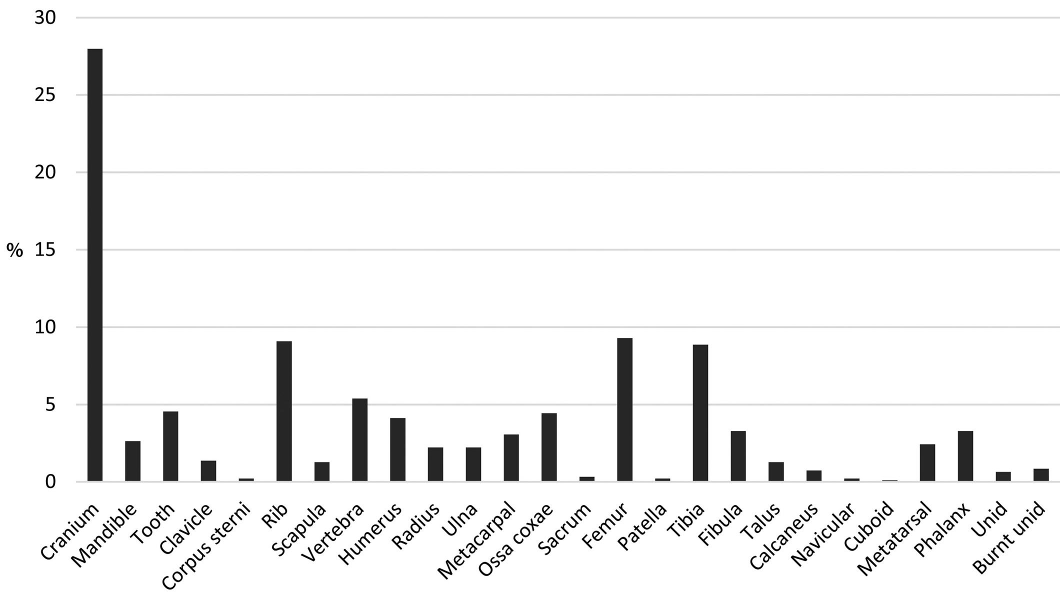

Fig. 2. Skeletal elements represented as a percentage of the total assemblage (unid: unidentified bone fragment).

element frequency within the assemblage, dividing the number of identified specimens (NISP) for each element by the overall total. Almost all skeletal elements are represented in the Tinkinswood assemblage, although carpals and the smaller tarsals (cuneiforms) are noticeably absent. Cranial fragments comprise more than one quarter of the assemblage (n=265). Fragile elements with a higher composition of trabecular bone such as the *corpus sterni*, sacra, carpals and tarsals, are less well represented. It is possible that they were never deposited within the tomb, but given the higher representation of metacarpals and metatarsals, in comparison to carpals and tarsals, this does not seem to be the case. As Ward stated (in Keith 1916, 276, footnote 1), the recovery of bone was impeded by the clay matrix, indicating that it may have been these more friable elements which were not recovered. It is also possible that diagenetic processes contributed to their higher rate of destruction, as the representation of long bone epiphyses, similarly mostly composed of trabecular bone, is much lower than that of diaphyses (Fig. 3). This selective recovery may have altered the expected pattern of attrition in relation to bone density, such that fragile elements appear to be less well preserved than they probably were.

The relative completeness of skeletal elements reveals the highly fragmentary nature of the material. From a total of 903 fragments of bone (loose teeth have been excluded), only 83 fragments represent more than 80% of the original element, and this number is composed largely of small bones of the hands and feet. Small bones are often under-represented archaeologically, relative to other skeletal elements (e.g. Bello and Andrews 2006; Mays 1992). Whilst this is also the case at Tinkinswood, their general completeness is perhaps surprising given the fragmentary nature of all other skeletal elements. Their presence in the assemblage is a strong indicator of primary interment. Since these elements are often the first to disarticulate during decomposition, and may therefore be affected by scavenging and scattering, they would not be expected to be represented in such frequency in secondary deposition contexts (Haglund 1997; Duday 2009). Their preservation may be explained by a model wherein, due to early disarticulation,

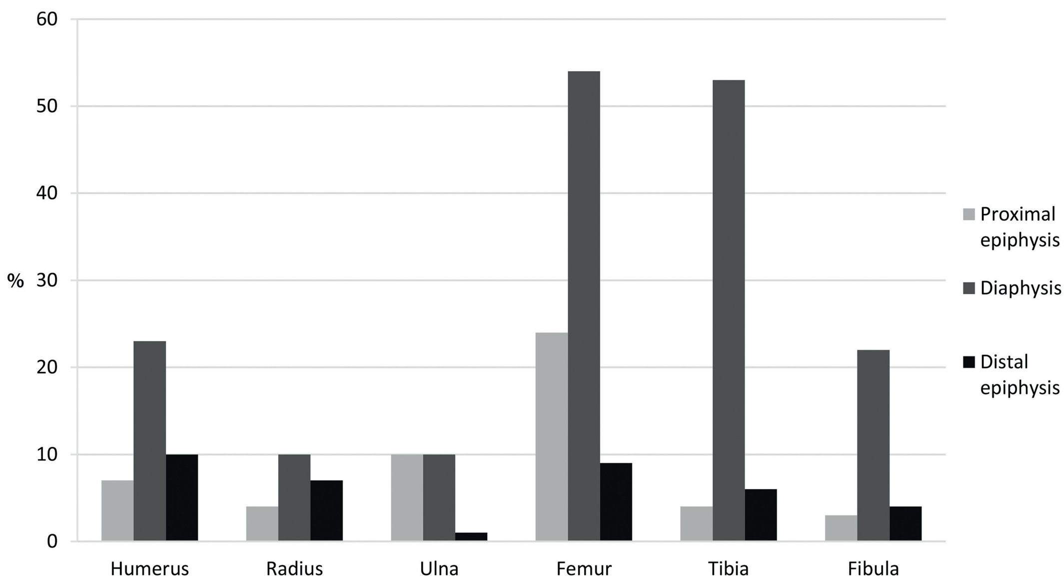

Fig. 3. Representation of the number of cortical (diaphysis) to trabecular (proximal/distal epiphysis) bone fragments from all identified long bones.

they fell to the base of the chamber through the space created by the decomposition of other soft tissues. This phenomenon was noted in the late medieval mass grave at Towton (Sutherland 2000).

Taphonomic observations are summarised in Table 1. Only ten fragments displayed evidence of weathering through longitudinal cracks in the cortical surface of long bones. An experimental study in Wales (Andrews 1995) has shown that bone can be exposed to the elements in a temperate environment for over a decade before producing the characteristics defined by Behrensmeyer's (1978) study in East Africa. Furthermore, bone in wet and sheltered conditions may display erosion at epiphyses comparable to canid gnawing (Andrews 1995). A similar phenomenon was noted on a handful of specimens from Tinkinswood, where punctures and trabecular erosion would seem to suggest gnawing, but no associated furrowing marks were present (Fig. 4, a). This may suggest that some previously exposed remains were bundled up and redeposited in the tomb. Keith (1916, 271) noted that the 'roof of the chamber is not water-tight', providing an alternative possible explanation for the weathering of the remains, although in this case weathering would be expected across a larger portion of the assemblage. Root etching was not widespread; in some cases roots seemed to have combined with mineral action to produce chalky curvilinear grooves, particularly evident on tooth enamel (Fig. 4, d). Discolouration of bone surfaces is mainly the result of mineral staining, in the form of black speckling, likely attributable to manganese (Fig. 4, c).

Table 1. Summary of taphonomic processes affecting the assemblage

Taphonomic process	Percentage
<½ complete	79%
Cutmarks	0%
Gnawing	0%
Root etching	0.7% (n=7)
Weathering	1.1% (n=10)
Burning	2.3% (n=22)
Discolouration	3.5% (n=33)
Fragmentation	88% (n=834)

No evidence for cut marks or either canid or rodent gnawing was identified. This suggests the chamber was closed between interments and remains were not exposed before deposition. Analysis of the fracture morphology of long bone fragments reveals that most fractures (84.7%) occurred on dry bone. Smooth, curved fractures (Fig. 4, b), which may indicate breakage during the perimortem interval, were noted on only a few fragments (1.4%). Recent breaks, likely the result of excavation damage, were present on 13.9% of long bone fragments.

Burning was observed to varying extents on 22 fragments of bone, consistent with exposure to different temperatures, or varied levels of oxygenation according to location on the pyre. Ten fragments were calcined with some evidence of cracking, indicating full oxidation, nine fragments were burnt black, and one fragment was burnt grey, representing incomplete oxidation. Two fragments exhibited evidence of uneven black charring. Fourteen of the cremated fragments are from cranial bones, representing the individual that Keith (1916, 269) identified as a child. The other fragments are unidentifiable to element, although a few derive from long bone diaphyses. The diaphyseal fragments appear to be too large to represent a nonadult, indicating the interment of the partial remains of a minimum of two individuals.

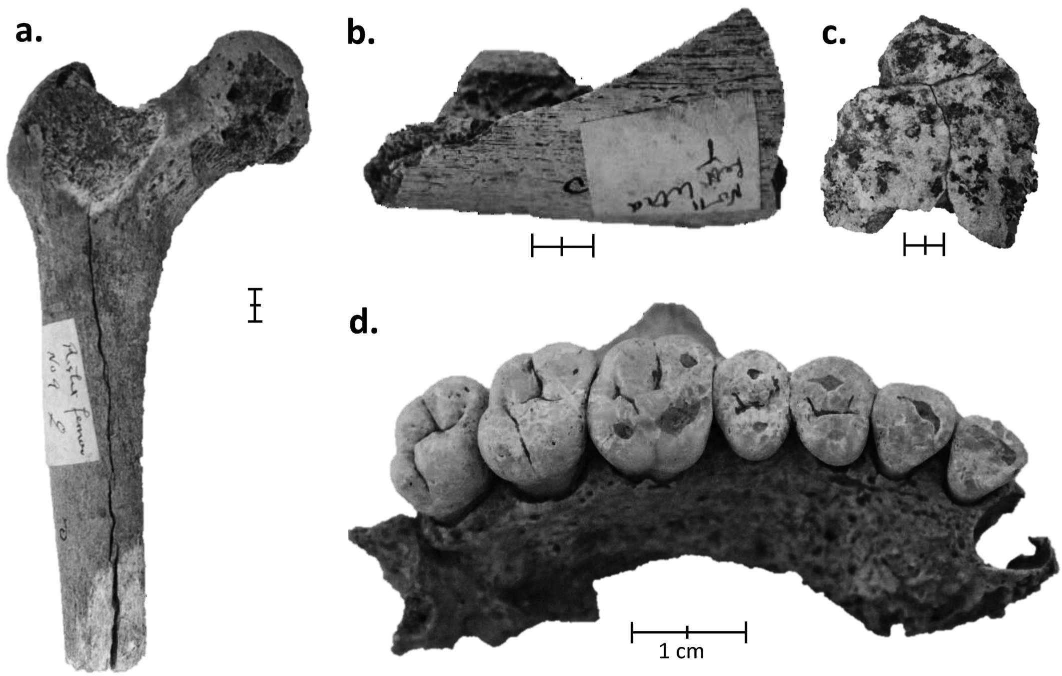

Fig. 4. a – weathered femur; b – fractured tibia fragment; c – mineral staining on a cranial fragment; d – root etching on maxillary dentition (scale bar: 1cm). © *J. E. Thompson with kind permission from the National Museum of Wales*.

Demography and element representation

As detailed above, adult and nonadult remains were quantified separately to estimate the MNI. A minimum number of elements (MNE) was calculated for all major bones or regions of bones, from each side of the body, based upon the presence of diagnostic zones or features. Elements of the axial skeleton, or those unable to be assigned to side (e.g. phalanges, nonadult long bone diaphyses) were tabulated separately. Combined results for both adult and nonadult individuals are presented in Table 2. The highest adult MNI, of ten individuals, was obtained from reconstructed crania and frontal bones, and the highest nonadult MNI was obtained from eight left femora. Including the small number of cremated remains from at least one adult and one nonadult individual raises the total MNI from Tinkinswood to 20 individuals. The extent of degradation of the skeletal material is clear from estimates of the expected number of remains in relation to the MNI (Table 3). The NISP represents only 17.5% of the estimated total of skeletal elements.

The results of sex determination were inconclusive, as it was not possible to observe all sexually dimorphic traits across any one skull or pelvis, and no crania could be matched with their associated mandibles or *ossa coxae*. Both cranial and pelvic traits do suggest, however, that more males than females are represented in the assemblage. Adult age estimates were obtained from the analysis of dental attrition of seven mandible fragments. Three individuals from the adolescent to young adult age range are present (17–25 years old), and four young to middle age adults are present (25–45 years old). Only two isolated pubic symphyses were complete enough to analyse and, again, the results are not conclusive, as symphyseal morphology should ideally be viewed bilaterally. One individual was estimated to be 23–57 years old, and the other between 27–66 years old at the time of death. Estimation of nonadult age from

Table 2. NISP (total number of identifiable fragments), MNE (tabulated according to side) and BRI (representation of skeletal elements accounting for MNI) for all skeletal elements

	NISP	Left	Axial/ Unsided	Right	BRI
Cranium	265	–	11	–	55
Mandible	25	10	–	7	0
Hyoid	0	–	0	–	0
Cervical vertebrae	12	–	8	–	5.7
Thoracic vertebrae	19	–	11	–	4.6
Lumbar vertebrae	18	–	12	–	12
Sacrum	3	–	1	–	5
Os coxae	42	7	–	9	40
Corpus sterni	2	–	2	–	10
Rib	86	17	–	9	5.4
Clavicle	13	3	–	3	15
Scapula	12	2	–	2	10
Humerus	39	6	1	6	30
Radius	21	3	–	4	20
Ulna	21	5	–	6	27.5
Carpals	0	0	–	0	0
Metacarpals	29	11	–	9	10
Manual phalanges	19	–	19	–	3.4
Femur	88	16	–	8	60
Patella	2	2	–	0	5
Tibia	84	7	1	4	30
Fibula	31	2	–	3	12.5
Talus	12	4	–	8	30
Calcaneus	7	3	–	4	17.5
Tarsals	3	1	–	2	1.5
Metatarsals	23	10	–	8	9.5
Pedal phalanges	7	–	7	–	1.4

dental eruption reveals at least three infants and children between 1.5 and 4.5 years old, alongside an older child of approximately 11–12 years. It is evident that, as at other Neolithic funerary monuments, individuals of all ages and both sexes were interred in Tinkinswood.

Skeletal element representation was calculated for all major elements (Table 2). As the element representation curve shows (Fig. 5), most elements, particularly small bones of the extremities and the elements of the axial skeleton, are significantly under-represented. Skeletal element representation is roughly similar between adults and nonadult individuals, with mandibles, *ossa coxae* and femora highly represented across all ages. Curiously, however, fewer nonadult crania are present; this may be due to their overall high fragmentation, but it remains possible that some may have been removed from the tomb. It is evident that *in situ* attrition and recovery biases have both adversely affected fragile nonadult elements, as vertebrae, *corpus sterni*, and bones of the hands and feet are almost entirely absent. The under-representation of small bones is the expected pattern in cases of both successive deposition and secondary deposition (Robb 2016, 690). The former scenario is more likely in this case. As already

Table 3. Potential NISP compared to actual NISP
Estimates of 156 bones for fetal-infant age individuals and 332 bones in child-adolescent individuals were used, following Lewis (2006, 26) and 206 bones for adult individuals, although it is recognised that numbers are highly variable within nonadult skeletons.

MNI	Potential NISP	Actual fragments	Actual NISP	% of potential NISP present
20	Total= 5,410 Infant (1 × 156) Child (9 × 332) Adult (11 × 206)	949	943	17.5%

discussed, selective recovery methods have suppressed the numbers of small bones, making these an unreliable marker of funerary practices. It is possible that metacarpals/metatarsals may have originally been present in similar numbers as the larger talus and calcaneus (30% and 17.5% respectively). The low presence of vertebrae indicates these, too, were probably recovered in smaller numbers than were originally present.

All long bones, except for the femur, represent less than 50% of the MNI. This may suggest that some long bones were intentionally removed from the chamber while it was still in use, although the potentially

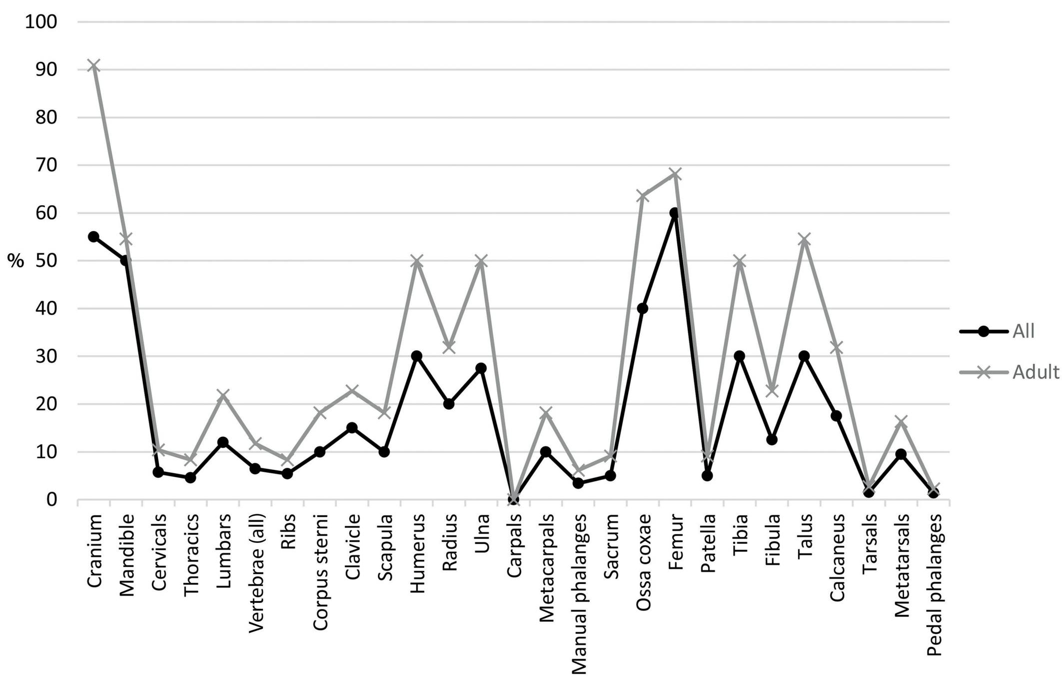

Fig. 5. Skeletal element representation at Tinkinswood (elements calculated as a percentage of the MNI).

higher degradation of nonadult remains has suppressed these figures. The low numbers of radii (20%), ulnae (27.5%) and fibulae (12.5%) are perhaps less surprising, as these elements are small and narrow in cross-section and are often adversely affected by fragmentation. However, humeri and tibiae both account for only 30% of the MNI and represent larger diaphyses with thicker cortical bone. Their low presence in the assemblage is harder to account for through *in situ* destruction and may suggest that some long bone removal was specific to certain elements. While it is evident that fragmentation has resulted in many long bones preserving as only small diaphyseal fragments — rendering them difficult to accurately account for quantitatively — their generally uneven representation indicates some selective removal. Accounting for the minimal evidence of weathering, it is possible that alongside practices of primary interment and long bone removal, the occasional secondary deposition of curated and exposed elements, as well as cremated remains, were all represented at Tinkinswood.

INTER-SITE COMPARATIVE ELEMENT REPRESENTATION

Compared to results from other contemporary monuments[1] it is clear that element representation differs at each site, reflecting a range of factors including varied depositional practices, excavation and curation techniques (Figs 6 and 7). At Tinkinswood, Burn Ground, Poulawack and West Tump, small elements with a high proportion of trabecular bone are typically under-represented, as illustrated in Figure 6 (Beckett 2011; Smith and Brickley 2009). This is likely a result of low bone density resulting in higher *in situ*

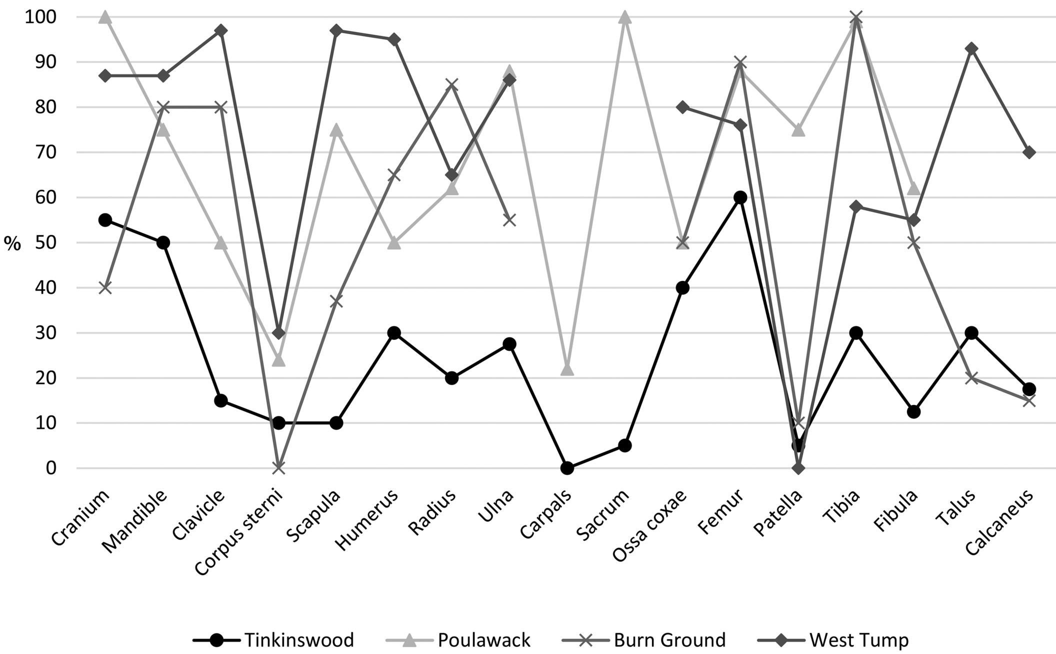

Fig. 6. Skeletal element representation at Tinkinswood and comparative Neolithic sites with similarly uneven element representation curves due to practices such as bone removal, secondary deposition and disturbance.

attrition, although the early excavation of these sites may have also resulted in less comprehensive bone recovery.[2] Differences are noted in the representation of crania and long bones at each monument. Crania comprise only 40% of the MNI at Burn Ground, indicating practices of selective removal. Of the long bones, humeri and ulnae at Burn Ground and tibiae at West Tump may have been selectively removed (Smith and Brickley 2009, 71), comparable with the scenario proposed above for Tinkinswood. At Poulawack, successive primary interments are indicated, although complex histories of disturbance and manipulation during the placement of subsequent inhumations resulted in an uneven pattern of element representation (Beckett 2011).

Although less dense elements (i.e. sterna, patellae, hand and foot bones) have not preserved well at Parknabinnia and Wayland's Smithy, they are better represented than at Tinkinswood, revealing less destructive taphonomic processes at these sites (Fig. 7). Excavation photographs and records at both of these monuments reveal preserved articulating bone groups and more intact skeletal remains (Brothwell and Cullen 1991; Whittle 1991; Beckett 2011). The result is a much more even representation of skeletal elements at both Parknabinnia and Wayland's Smithy, reflecting less disturbance. *In situ* articulations were recorded at both sites, and a refitting study at Parknabinnia showed some evidence of bone movement between the chambers (Beckett 2011). This proportional representation, along with the presence of small bones of the hands and feet, is clear evidence for the dominant practice of primary inhumation.

Conversely, more fragile elements are well represented at both Poulnabrone and Quanterness (Fig. 7). At Poulnabrone, practices of successive inhumation and subsequent removal of some long bones is indicated (Beckett 2011). An almost proportional representation of skeletal elements is seen at Quanterness, although mandibulae and femora are slightly under-represented. The argument for their

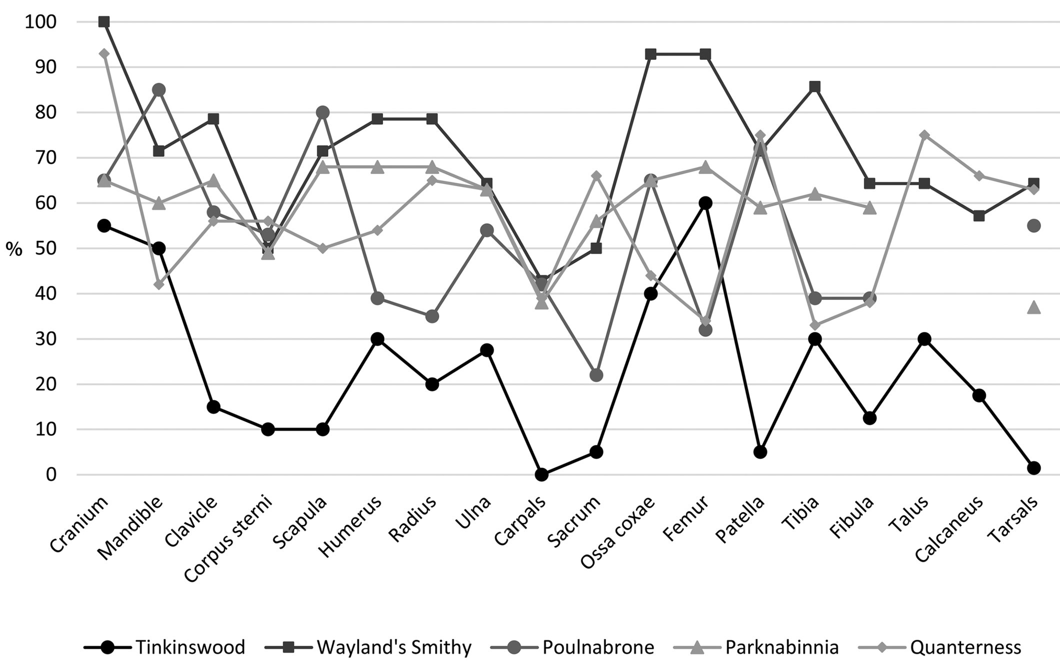

Fig. 7. Skeletal element representation at Tinkinswood and comparative Neolithic sites with more proportional representation of elements.

selective removal is challenged, however, due to the high fragmentation of these elements (Crozier 2018). Fragmentation does not explain the under-representation of long bones at Poulnabrone; they are genuinely few in number, indicating cultural practices have affected their preservation.

In comparison with element representation at contemporary sites, Tinkinswood is notable for its particularly low preservation of most skeletal elements, especially long bones. Typically, this would be interpreted as the result of practices of secondary deposition. Due to the evidence for selective excavation and recovery techniques, taphonomic degradation of fragile bones, and high levels of fragmentation, this does not seem to be the case. The historic movement and removal of skeletal material from the chamber, noted by Ward (1916, 244), likely also affected bone preservation, causing further fragmentation. Given better environmental and excavation conditions, a more proportional representation of skeletal elements would be expected. The pattern of element representation bears some similarities to Poulawack: primary, successive interments are indicated by the presence of hand and feet bones, but disturbance of remains and possible removals have resulted in an uneven distribution of elements. Evidence for the rearrangement of skeletal elements is seen at the nearby monuments of Ty Isaf and Pipton, where bones were pushed to the edges of the tomb (Burrow 2006), and this may be comparable to practices which occurred at Tinkinswood.

RECONSIDERING THE TINKINSWOOD ASSEMBLAGE

Despite the limitations provided by the excavation and recovery methods, there are some important inferences to be drawn from this study. These results challenge both some long-held conclusions and recent interpretations of the Tinkinswood material. Keith's (1916, 276) estimation that 50 individuals were represented in the assemblage has been considerably revised. The high levels of fragmentation and process of successive interment will have impacted the estimation of MNI, almost certainly concealing a higher number of individuals (see Robb 2016 for further discussion of this). It is certain, however, that the original total was arrived at erroneously, using inaccurate methods.

This study has identified a minimum of 20 individuals in the Tinkinswood assemblage. Although it is impossible to confirm whether the Neolithic remains from the nearby barrow originate from Tinkinswood, it is a feasible hypothesis and suggests the MNI presented here may be expanded. Furthermore, as noted by Smith and Brickley (2009, 89), nonadult remains in general seem to have been less affected by post-depositional degradation than adult remains. In circumstances of poor preservation, such as at Tinkinswood, this results in the nonadult MNI appearing almost equal to the adult MNI, which is almost certainly a result of taphonomic bias. Although the MNI does not equate with the *original* burial population at Tinkinswood, it may indicate a general pattern of fewer individuals having been deposited in single chamber tombs, as opposed to multiple chambered tombs. Only at a few exceptional sites have the remains of more than 30 individuals been preserved, and most are transepted or lateral chambered tombs. Between 35–42 individuals were identified at Hazleton North (Rogers 1990), 36 at Poulnabrone (O'Donnabhain and Tesorieri 2014), around 40 individuals at Parc le Breos Cwm (Whittle and Wysocki 1998), and 46 at West Kennet (Bayliss, Whittle, *et al.* 2007).

New insights into depositional practices have also been revealed. Individuals of both sexes were interred and nonadult individuals highly represented. Only those below one year of age have not been identified. It is difficult to ascertain whether this accurately reflects a picture of excluding 'babies and infants' from collective burial spaces, given both the high level of disturbance and selective recovery. Contrary to Keith's (1916) interpretation, perimortem breaks occurring to fresh bone were rarely noted, indicating that, if remains were manipulated during the perimortem interval, such acts were sufficiently careful to avoid breaking bones. The minimal evidence for weathering may be congruent with secondary deposition of a small number of curated elements. It is therefore probable that bodily integrity was respected in the early stages after death. The evidence for the movement and rearrangement of skeletal remains cannot be fully assessed, due to the lack of excavation records, but the profile of element representation strongly indicates that selected long bones were removed from the tomb. These acts exploited the partibility of the body after death, perhaps resulting in the circulation of disarticulated remains amongst the living before their redeposition elsewhere in the landscape.

The limited number of radiocarbon dates available for Tinkinswood hinder understanding of the temporality of site use and depositional activities. This analysis has shown, however, that most depositions occurred soon after death. Selected long bones were removed from the monument, and practices of secondary deposition, including the interment of cremated remains occasionally occurred. It is unclear whether these multiple methods of disposal were relatively contemporary or represent successive phases of the monument's use. While the evidence from other chambered tombs does indicate the co-existence of multiple disposal methods, as discussed earlier, there are a few differences which suggest Tinkinswood may have been a multi-phase monument. Firstly, different interpretations exist as to whether the cist is contemporary or later in date (Darvill 2004; Reynolds 2014; Reynolds and Adams 2014), and secondly, the Beaker sherds found within the chamber may indicate reuse of the monument for burial. Although it is not possible to identify which bones originated from the cist, the taphonomic results contradict the suggestion that the cist was used as a site for excarnation (Reynolds and Adam 2014).

Tinkinswood clearly retained significance for ritual and funerary purposes into the Bronze Age, as attested by the construction of barrows nearby (Pannett 2012). The chamber was re-opened during this period; at this time, the remains of the earlier interments may have become partially buried due to soil influx, and *in situ* taphonomic degradation would have begun to alter their preservation. It is difficult to ascertain whether the burial deposits were further disturbed or added to in the Bronze Age, but a Beaker and whetstone were both placed within the tomb, perhaps as a form of offering. This kind of interaction with earlier burial monuments is not uncommon in the wider area (Smith and Brickley 2009, 139). An inhumation with a Beaker was deposited at Sale's Lot (O'Neill 1966, 24) and Bronze Age cist burials were inserted into the Penywyrlod (Talgarth) cairn (Thomas 1999, 151). Furthermore, cremated bones alongside Beaker pottery were inserted into cists at the Dalladies long barrow (Piggott 1972, 36–38), and middle Bronze Age pottery was associated with cremated bones at Ty Isaf (Grimes 1939). Although the spatial association between the cremated remains and the Beaker sherds at Tinkinswood is not known, it is possible they represent Bronze Age secondary depositions.

CONCLUSION

This work continues to demonstrate the value of re-analysing material arising from antiquarian excavations. Tinkinswood has been frequently overlooked despite the precedent set over the past two decades in research which has considerably advanced our understanding of Neolithic funerary practices in Britain. As shown by numerous studies (e.g. Brickley and Thomas 2004; Smith 2006; Smith and Brickley 2009), original accounts of the human remains excavated from Neolithic monuments are often incomplete or inaccurate. It is crucial that fragmented and commingled assemblages receive the attention they deserve, and as taphonomy continues to develop as a field, the potential for new insights into past funerary practices increases.

The results of this study reveal both broad trends and specific differences. Tinkinswood fits comfortably within the context of early Neolithic burial practices, indicating the successive primary interment of multiple individuals. This re-analysis has reduced the number of individuals identifiable from the human remains, and this figure compares well to other contemporary monuments, especially given the small size of chamber. It is recognised, however, that taphonomic processes, including excavation methods, have impeded the calculation of the MNI and the total original burial population would have been larger. In contrast to other contemporary monuments, Tinkinswood is exceptional for the low representation of most skeletal elements. This is linked to its history of disturbance (which resulted in the movement of tomb contents as well as the scattering of some remains outside the chamber) and circumstances of excavation, as the clay matrix impeded the full recovery of small, fragile bones. Taphonomic analysis reveals that remains were manipulated after decomposition, and selected long bones removed from the tomb. However, questions remain as to how long the monument was in use for during the early Neolithic, and whether Tinkinswood can be classified as a multi-phase monument. There is potential for further work to address the full history of the site's use, and place Tinkinswood more firmly in the chronology of early Neolithic funerary monuments.

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NOTES

1. For some of these comparative sites, element representation has been calculated by dividing MNE by MNI to express each element as a percentage of the expected MNI. This is slightly different to BRI, which aggregates elements from both sides instead of taking the side with the highest MNE. The overall trend is the same using both methods, but there may be slight differences. Additionally, all assemblages have been reported differently, and the results for some skeletal elements are missing at some sites.
2. Although Beckett (2011, 407) found that bone recovery at Poulawack was particularly good despite the early excavation.

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