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Radiocarbon and histo-taphonomic evidence for curation and excarnation of human remains in Bronze Age Britain.

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Abstract

Partial cremated and unburnt human remains have been recovered from a variety of British archaeological contexts dating from the Chalcolithic to the Earliest Iron Age (c. 2500-600 BC). Chronological modelling and comparison of 189 radiocarbon dates from a selection of these deposits provides evidence for systematic curation of human remains for two generations on average. Histological analysis of human bone using micro-CT indicates mortuary treatment involving excarnation and exhumation of primary burials. Curated bone came from people who had lived within living or cultural memory, and their power was probably derived from the relationships between the living and the dead.

Introduction

Recent analysis of grave goods from burials dating from the British Chalcolithic and Early Bronze Age has demonstrated that the curation of significant artefacts was an important social practice (Sheridan *et al.* 2002; Woodward 2002; Hunter & Woodward 2015). Often, this involved the deliberate fragmentation of objects such as necklaces and daggers as part of the funeral rite – a practice, it has been argued, that allowed portions of such 'heirlooms' to be retained by the living (Jones 2002; Brück 2004; Brück 2019). Historically, discussion of Bronze Age mortuary rites has focused on practices – such as complete individual inhumation burials with grave goods – that appear to substantiate dominant social evolutionary narratives of growing complexity. Increasingly, however, it has been recognised that Bronze Age funerary practices were in fact highly variable (Petersen 1972; Sofaer Derevenski 2002; Gibson 2004; Brück 2006; Appleby 2013; Fowler 2013). Chalcolithic and Early Bronze Age burials often include partial, disarticulated skeletons. In some cases, for instance when disarticulated human bones are found strewn through grave backfill, these may have been accidentally redeposited from disturbed primary inhumation burials. However, in other cases the representation of skeletal elements, the ways in which they have been modified and the nature of deposition suggest levels of care indicating intentional deposition. A significant question remains, therefore, whether human bones – like other artefacts – were deliberately curated in practices that involved their fragmentation, circulation and redeposition over protracted periods of time.

During the later part of the Early Bronze Age and subsequent Middle Bronze Age, cremation burial was also common (Ellison 1980; Caswell & Roberts 2018). Deposits of cremated bone often do not weigh enough to account for a whole individual (Brück 2009; Brück 2006). Although this could be explained by the retrieval of only small quantities of cremated bone from the pyre, it is also possible that the cremated remains were divided between mourners in practices that involved the deliberate retention of the bones of the dead. Some cremation burials contain the burnt remains of multiple individuals. Contexts containing the remains of two or three individuals could be explained by simultaneous cremation or cremation on the same pyre site. However, in certain cases the number of individuals represented is too high for this

to be plausible, and it is more likely that cremation burials had been intentionally accumulated.

During the Late Bronze Age and Earliest Iron Age, fragments of disarticulated unburnt bone as well as small quantities of cremated bone were frequently deposited in and around settlements in roundhouses, waterholes and field boundaries (Brück 1995). Patterning in the skeletal representation and the spatial distribution of these finds suggests that they were deliberate deposits. As yet, it is unclear whether such finds represent the endpoint of prolonged funerary rituals involving the defleshing, fragmentation and selective redeposition of certain remains, or systematic curation, where disarticulated and cremated human bones were intentionally retrieved and preserved for substantial durations of time before they were deposited. Continued interest in old objects during this period is indicated by the inclusion of 'out-of-time' artefacts in Late Bronze Age hoards (Knight 2019).

The recognition of diversity in mortuary practices in the Bronze Age forms part of wider discussions around the significance of the dead and concepts of the body and the self in prehistory (Fowler 2010). The complexity of Neolithic mortuary deposits has been well described (e.g. Wysocki & Whittle 2000; Smith & Brickley 2009); the architecture of Neolithic tombs often made it possible to retrieve human bone for manipulation, circulation and redeposition in other contexts. In the Iron Age, it has been argued that the skulls of enemies were curated and displayed (Armit 2012), although the careful deposition of very old human remains suggests that rediscovered bones may sometimes have been identified and venerated as 'ancestors' (Armit & Ginn 2007).

The primary question we will address in this paper is whether radiocarbon dating can provide evidence for the systematic curation of unburnt and/or cremated human bone from the British Chalcolithic to the Earliest Iron Age (2450-600 BC, hereafter referred to as British Bronze Age for convenience). We will then go on to investigate for how long any curated bones were kept before being deposited. Establishing the timescales of these practices will help us understand how these remains may have been perceived by the communities to which they belonged, and potentially provide some insight into the ideologies which drove these practices and gave curated

human remains their power. It will be important to try to distinguish, for instance, whether bones could conceivably have come from the remains of someone that the community knew in life (i.e. a recent or known ancestor linked with a specific family or lineage) or someone from the distant past who existed well outside of living or cultural memory (i.e. an anonymous or mythical ancestor linked more broadly with the entire community).

Unburnt disarticulated bones suitable for curation may have been obtained in a number of ways. Firstly, bodies may have been dismembered and defleshed. In fact, few Bronze Age human bones show cutmarks indicative of such processes, although this would have been dependent on skeletal representation/completeness and the dexterity of the person processing the body (Fisher 1995). Secondly, disarticulated bones may have been exhumed from old primary burials. Thirdly, excarnation (sub-aerial exposure) may have been practiced, although the evidence for it, normally constituting patterns of carnivore modification and characteristic weathering such as longitudinal cracking (Carr & Knüsel 1997; Smith 2006), is ambiguous, as its presence would be dependent on the nature of rites (e.g. the duration the defleshed bone was exposed to the elements and the extent to which the environment was sheltered and the remains protected from large scavengers). Histological analysis of Bronze Age human skeletons from Britain found evidence that some had previously been mummified and fragmented (Parker Pearson *et al.* 2005; Booth *et al.* 2015). It is possible that certain Bronze Age disarticulated bones represent the fragmented remains of bodies that had been mummified or partially-preserved. We will employ histological analysis to address aspects of the depositional histories of unburnt bones and to assess whether the treatment of the body might relate to any curation practices.

Radiocarbon dating

We generated 82 new radiocarbon dates at the Bristol Radiocarbon Accelerator Mass Spectrometer Facility (BRAMS) for human remains (38 unburnt, 16 cremated), and associated material from the same or associated contexts (22 on unburnt faunal bones, 2 on burnt bone, 3 on charcoal and 1 on a hazelnut shell). The latter were taken to represent the date (or at least a *terminus ante quem*) of deposition. It is

impossible to control entirely for the possibility that some of these human remains were accidental inclusions, but we tried to mitigate against this possibility by focussing sampling on discrete large fragments of bone that were plausibly recognisable as human bones (skulls and long bones) and had been placed on prepared surfaces rather than retrieved from fills or mixed dumps of material. We did not restrict our sampling geographically, as we were uncertain as to how many relevant contexts we would find, and we needed to prepare for the likelihood that radiocarbon dating would occasionally fail.

We combined our dates with 121 previously-published Bronze Age radiocarbon dates on disarticulated human remains, cremated human bone and associated materials, including three sites that had been found previously to include remains showing evidence for mummification (Booth *et al.* 2015; Parker Pearson *et al.* 2005; Smith *et al.* 2016; Fig.1; Supplementary Table S1). At three sites where there was no available dateable associated material or where radiocarbon dating of associated material failed due to the poor collagen preservation we compared radiocarbon dates of potentially-curated material against broad calendrical date ranges inferred by artefact typology. In cases where we had dates from the same stratigraphic context, we assessed agreement indices and X^2 tests generated as part of the Combine function in OxCal 4.3 using the IntCal13 curve to test the hypothesis that the individual's date of death and deposition were contemporaneous (Bronk Ramsey 2009; Reimer *et al.* 2013). In cases where we had dates from stratigraphically related contexts, we used agreement indices generated by chronological modelling to assess how well dates from potentially curated material fit with their stratigraphic positions. We flagged anomalous dates when agreement indices fell below 60 (Bronk Ramsey 2009; Supplementary Tables S2 and S3).

A minority of samples we tested produced dates after 600 BC. Post-Iron Age dates are provided in Supplementary Table 1 but are not discussed in detail here. Of the 60 Chalcolithic, Bronze Age and Iron Age archaeological contexts we tested, 26 (43%) contained human bones that were anomalously older than dates relating to their deposition (Fig.2). One of the contexts we included, a Chalcolithic burial from West Cotton, consisted of a collection of disarticulated human remains recovered from a shallow pit beneath the base of a grave containing a single articulated

inhumation. It was difficult to say whether the disarticulated bones had been intentionally deposited with the burial, or if by chance the grave had been placed over an earlier Neolithic pit containing disarticulated human remains (Harding & Healy 2013). The offset between the dates of the articulated skeleton and the disarticulated bones in this grave is a notable outlier, which combined with the uncertain stratigraphic relationship resulted in us excluding these results from further tests. In three cases disarticulated faunal bone taken to reflect the date of deposition was actually anomalously older than the human bone, indicating incidental inclusion of old faunal material, or possibly curation of old faunal remains.

When the anomalous West Cotton burial and the four later Iron Age contexts (defined here by the median value of their calibrated radiocarbon date distribution falling after 600 cal. BC) were removed, 23 out of 55 Bronze Age bones (42%) were anomalously too old (showed agreement indices <60 or failed the X^2 test because they were too old; see Supplementary Table 2 and the Supplementary Materials Section 1). Out of 36 cases where we used the Combine function and performed X^2 tests, 13 (36%) failed. We would expect that 5% of X^2 tests to fail by chance (Bronk Ramsey 2009). A one-tailed proportions test of our X^2 test results against an invented similar-sized sample where 5% fail (i.e. n=36, 34 non-significant and 2 significant results) suggests that the rate of failure in our Bronze Age samples is significantly higher than what we would expect to find by chance (z=3.1921, p<0.001, Bonferroni p-value threshold = 0.013). It is difficult to define a threshold of statistical significance for all outcomes including those where we only have agreement indices. A one-tailed proportions test of our Bronze Age results against an invented, similar-sized sample with an arbitrary but conservative 20% rate of anomalous results (i.e. 44 non-significant and 11 significant) indicates that there were significantly more anomalous results in our Bronze Age sample (z=-2.4759, p=0.007, Bonferroni p-value threshold = 0.013). Anomalous dates were detected through all phases of the Bronze Age.

We produced unmodelled probability distributions for the differences between death and deposition of human remains for each context using the Difference function in OxCal, providing us with some indication of the time periods over which human remains were retained (Figs. 3 & 4). We produced similar distributions (Intervals) for

differences between dates from human bones and associated material in the Bchron program. We summed all of our BChron Intervals in R by combining them as a vector (Haslett & Parnell 2008; R Core Team 2013). We tested whether our combined Bronze Age Interval distribution was significantly lower than 0 (i.e. significantly early) by comparing it against a control sample consisting of a normal distribution with a mean of 0 and a similar standard deviation to our observed distribution (n=560,000, mean = 0, standard deviation = 178.2408), using a one-tailed Wilcoxon rank sum test (Fig. 5). The result indicated that our summed Bronze Age Intervals were significantly older than the control (W=1.183 x 10^{11}, p<0.001, Bonferroni p-value threshold = 0.013). This result provides further evidence in addition to the X^2 tests and chronological modelling for the presence of anomalously old human remains in our sample set and is consistent with curation of human bone through the Bronze Age.

We noticed that Bronze Age intervals which were not significantly anomalous were still slightly offset from a comparable control (normal distribution, n=340,000, mean = 0, standard deviation = 181.0332; Fig. 6). Bronze Age human remains which were curated for decades or sometimes centuries would not always show up as anomalously old using the tests provided in OxCal (Supplementary Materials Section 2). We performed another one-tailed Wilcoxon rank sum test of our combined Bronze Age intervals with all the anomalous intervals removed against the control distribution described above. This Bronze Age distribution without anomalous dates was significantly older than the control (W=5.0121 x 10^{10}, p<0.001, Bonferroni p-value threshold = 0.013), consistent with our hypothesis that this sample set likely includes curated human bones that do not show up in site-specific X^2 tests or agreement indices.

Radiocarbon dates from human remains can be significantly older than dates from their depositional context for a variety of reasons. For instance, if an individual obtained a large proportion of their dietary protein from marine or freshwater resources, the accumulation of old carbon in bone collagen produces a reservoir effect, making any associated date look early (Lanting & Van Der Plicht 1998). Fortunately, stable isotope analyses of human remains from Bronze Age Britain suggest that populations obtained very little of their dietary protein from marine or

freshwater resources (Parker Pearson *et al.* 2016). Δ¹³C values obtained on human bone from the Accelerator Mass Spectrometer as part of radiocarbon dating for samples included here provide no evidence for a substantial marine reservoir effect (Supplementary Table 1). However, our own stable isotope values and some of those that have been published previously were not acquired on the standard Isotope Ratio Mass Spectrometer (IRMS). Another possible source of error is that radiocarbon dates obtained from cremated human bone may not always represent an unadulterated signature representing the date of death (Olsen *et al.* 2013; Snoeck *et al.* 2014). Rather, carbon exchange between the bone and fuel during cremation means that the bone wholly or partially takes on the signature of the fuel. This could produce an old wood effect if the fuel was made up of heartwood from a long-lived species such as oak.

Seven contexts where cremated remains represented the posited curated material were analysed here, four of which produced anomalously early dates. The low number of cremated bones we included means that it is unlikely they had a major influence on our overall results. Cremated bones identified as significantly old were no older than unburnt bones producing significantly anomalous dates. We would expect that the old wood effect would produce a more uneven distribution of ages, so while we cannot rule out the possibility that the old wood effect could be responsible for these cremated bones looking too old, a scenario where cremated bones had been curated represents a plausible alternative (Olsen *et al.* 2013; Snoeck *et al.* 2014). Generally, our analysis of the radiocarbon data is best explained by human remains having been curated and deliberately deposited some years later.

The median of the combined Bronze Age intervals is 65 years older than the date of deposition with an interquartile range of 183 (1st quartile = -167, 3rd quartile = 16). Therefore, on average curated human remains were deposited by people who lived around two generations on from the death of the individual, although it is possible these bones could have come from an individual of the same generation or as many as six generations distant from the communities who finally deposited them. There is no discernible variation in intervals through the Bronze Age. We produced alternative Difference probability distributions within new phase models in OxCal 4.3 assuming that the all human remains we included had been curated and were older than the

materials used to date their deposition (Figs. 7 & 8). This produced artificial, idealised but narrowed intervals within younger ranges, emphasising that in most cases curation was likely to have been on the younger end of the unmodelled distribution of intervals/generational timescales.

These results suggest Bronze Age human remains were curated for relatively short periods of time, decades to a century or so. It is likely in most or all cases that curated human remains represented the remains of individuals whose identity was known and likely existed within living or cultural memory. It is possible that final deposition of their remains occurred when the individual was on the verge of passing out of living or cultural memory. The power of curated bone is likely to have lain in the identity of the individual to whom it belonged and their relationship to living individuals, whether familial or otherwise. Our results are inconsistent with curated remains representing distant, unknown and perhaps mythical ancestors linked to entire communities.

The Chalcolithic and Early Bronze Age human bones included here originate exclusively from funerary contexts. It is possible that that these old bones represent the movement of human remains between different funerary deposits, rather than curation practices *per se* where human remains were retained amongst living communities. At Windmill Fields, Ingleby Barwick, Stockton-upon-Tees in North Yorkshire, an intact burial of a young to middle adult female (Sk 6) was accompanied by disarticulated crania and long bones representing at least three individuals (Sk 8): a possible adolescent female, an adult male and an adult female (Annis *et al.* 1997; Fig. 9). The two adult crania are both anomalously older than the articulated burial, but contemporary with excarnated disarticulated human remains recovered from the remains of a wooden mortuary structure located a few metres away on the same site (Booth *et al.* 2015). It seems reasonable to speculate that the disarticulated bones accompanying the articulated burial had been retrieved from the cist and that this structure had acted as a cache of excarnated human remains that could be reused in later funerary rituals. If the remains of the dead were viewed as powerful or significant by living communities, all Chalcolithic and Early Bronze Age burials may have represented potential caches of bone.

The recovery of curated remains from Middle and Late Bronze Age settlements suggests that human bone may also have circulated amongst the living over protracted periods of time. At Striplands Farm in Cambridgeshire c. 225g of cremated human bone was deposited in a pit that formed part of a Late Bronze Age settlement (Evans *et al.* 2011); this was 89-7 years older (68% confidence) than burnt animal bone from the same context. Curated human bone may have had particularly potency when incorporated into deposits relating to the identity and lifecycle of the household group, such as foundation or abandonment deposits (Brück 1999; 2006). Yet, variability in the timeframes over which human bone was curated suggests that it may have been retained for many different reasons. There was a probable blade injury to the disarticulated frontal bone of an adult male from a pit on a settlement at Eye Quarry, Cambridgeshire (Patten 2004). The radiocarbon date from this bone was statistically consistent with one from an animal bone deposited in the same context. The skull fragment is therefore unlikely to have been curated over a long period (decades or centuries), although it may nonetheless have been displayed for a time (months or years) as a means of humiliating and intimidating a perceived enemy.

Histological Analysis

Bacterial bioerosion of internal bone microstructures varies in ways which correspond to early post mortem treatment, most likely because it is related in some way to soft tissue decomposition (Jans *et al.* 2004; Nielsen-Marsh *et al.* 2007; Booth 2016). Variation in patterns of bacterial attack can give an indication of the variety of taphonomic trajectories represented in a particular assemblage (Booth & Madgwick 2016). The relationship between the way bacterial bioerosion varies in remains from variable archaeological and forensic contexts, as well as broader models of bodily decomposition, can then be used to infer specific funerary rites. Previous analysis of patterns of bacterial bioerosion in Bronze Age human remains from Britain found that levels of attack were bimodally distributed, with around half showing high levels of bacterial bioerosion, most consistent with primary burial, and half showing little or no bacterial attack, most consistent with mummification or excarnation (Booth *et al.* 2015).

Seventeen Bronze Age human bones sampled for radiocarbon dating as part of this project were also subject to histological analysis using non-destructive micro-computed tomography (micro-CT) to investigate levels of bacterial bioerosion to infer diversity in patterns of treatment and investigate relationships to curation practices (Supplementary Materials Section 3). Levels of bacterial bioerosion in each scan were assessed by the analysis of virtual transverse slices using the standard Oxford Histological Index (OHI; Hedges *et al.* 1995; Millard 2001). Six samples show high levels of bacterial bioerosion (OHI<2), while the other 11 showed little or no bacterial attack (OHI>4; Supplementary Table 5; Fig. 10). This bimodal distribution of OHI scores is similar to the distribution recorded previously for Bronze Age human remains from Britain (Booth *et al.* 2015). Our results suggest that at least two taphonomic trajectories are represented amongst disarticulated remains included here, most likely reflecting distinct funerary treatments.

High levels of bacterial attack are most often found in bones recovered as part of articulated skeletons and originally buried as intact complete bodies soon after death (Jans *et al.* 2004; Nielsen-Marsh *et al.* 2007; Booth 2016). It is likely that Bronze Age samples showing high levels of bioerosion had been exhumed from primary burials post-skeletonisation. Anoxic or waterlogged environments inhibit osteolytic bacteria (Turner-Walker & Jans 2008; Booth 2016). Six of the eleven bones showing low or no bacterial attack originate from contexts, usually ancient waterholes, that were likely to have been waterlogged over the period of deposition, at least episodically. However, the disarticulation of these remains suggests that these environments did not represent the primary depositional context and were unlikely to have affected early bodily decomposition. In addition, there is no indication that most of these contexts were waterlogged when they were excavated. Bones from environments that are inundated periodically tend to show variable levels of bacterial attack (Booth 2016). This is unlike what is observed in the histologically well-preserved Bronze Age remains examined here, where bacterial bioerosion is usually absent or only slight. Early post mortem treatment is more likely to be responsible for levels of bacterial attack in the remains we have analysed here, particularly given patterns of bioerosion are similar to those observed previously in Bronze Age British remains from aerobic dry contexts (Booth *et al.* 2015).

Bones from aerobic contexts showing low levels of bacterial attack have usually been subject to funerary rites which rapidly removed soft tissue such as dismemberment, defleshing and excarnation (taken here to mean defleshing by sub-aerial exposure) or inhibited bodily decomposition, such as mummification (Jans *et al.* 2004; Nielsen-Marsh *et al.* 2007; Booth *et al.* 2015; Booth 2016). None of the bones sampled here show evidence for cut marks indicative of defleshing or dismemberment, and the simplest explanation is that they came from bodies that had been excarnated.

There is no temporal patterning in the histological results, suggesting bodies could be subject to both primary burial and excarnation during all phases of the Bronze Age in Britain. There was no relationship between radiocarbon evidence for bones having been curated and early post mortem treatment as indicated by levels of bacterial bioerosion. It would seem that most people were afforded specific funerary treatment that was deemed appropriate and that the decision to retain, retrieve and curate bones was made at a later stage.

Conclusions

A high proportion of unburnt disarticulated human remains and burnt human bone recovered from Bronze Age contexts in Britain were probably already old when they were deposited, providing the first clear evidence for systematic curation of human bone in this period. The duration of curation in these cases is fairly short: a few decades on average, and usually up to a couple of centuries at most. These timescales suggest that individuals represented by these remains had lived around two generations before the communities who eventually deposited their bones, and could have existed within their living or cultural memory. It is likely that these remains originated from known individuals and were kept by people or groups who had a defined relationship with the deceased, and that these relationships provided curated bone with its meaning and power. The results of this project reject a scenario where remains represent anonymous or mythic distant ancestors linked to entire living communities.

In the Chalcolithic and Early Bronze Age these old bones may not usually represent curation amongst the living, but significant remains retrieved from old graves or repositories to accompany new burials, although synchronous evidence for excarnation complicates this picture. In the Middle to Late Bronze Age and Earliest Iron Age, many our samples were recovered from settlement contexts. As such, their deposition may represent the end-point of complex trajectories where human remains were curated amongst the living. Analysis of bone diagenesis indicates no clear link between funerary treatment and curation, suggesting that these practices were considered separately. This study adds to the evidence for excarnation and the remarkable complexity of mortuary behaviour in Bronze Age Britain as well as to ongoing discussions around the power and significance of the dead in prehistory. It also contributes to current discussion of the importance of relational forms of personhood, for it suggests that the links between the living and the dead were central to the construction of social identities during this period.

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Figure 1: Map of British Bronze Age sites used in this study.

Figure 2: Offset between pairs of radiocarbon determinations representing the death and deposition (or terminus ante quem) of human remains plotted against jittered median calibrated radiocarbon dates of deposition (Supplementary Table S3).

Figure 3: Unmodeled Differences (68% confidence) between dates of death and deposition of human remains from Bronze Age Britain plotted against jittered median calibrated dates of deposition (See Supplementary Table S3).

Figure 4: Line graph showing variability in unmodeled Differences (medians and 68% confidence ranges) between dates of death and deposition through the British Bronze Age.

Figure 5: Violin plot showing kernel distribution of combined Bronze Age Intervals generated in BChron plotted alongside a normal distribution with the same sample size and standard deviation with a mean of 0. Kernel distributions were generated using the geom_violin function in the ggplot package in R Studio with default parameters (kernel = "gaussian", bw = "nrd0", scale =. "area"; R Core Team 2013).

Figure 6: Violin plot showing kernel density of combined Bronze Age intervals generated in BChron, with significantly anomalous dates removed, plotted alongside a normal distribution with the same sample size and standard deviation with a mean of 0. Kernel distributions were generated using the geom_violin function in the ggplot package in R Studio with default parameters (kernel = "gaussian", bw = "nrd0", scale =. "area"; R Core Team 2013)

Figure 7: Modelled Differences (68% confidence) between dates of death and deposition for Bronze Age human remains plotted against jittered median calibrated dates of deposition (See Supplementary Table S3).

Figure 8: Line graph showing variability modelled Differences (median and 68% confidence ranges) between dates of death and deposition through the British Bronze Age.

Figure 9: Sk 6 from Windmill Fields, Ingleby Barwick, Stockton-on-Tees accompanied by Sk 8 comprising the disarticulated remains (mostly skulls and long bones) of an additional three individuals (Tees Archaeology).

Figure 10: Vase plot showing kernel density and distribution of OHI scores for Bronze Age samples that were analysed histologically. They show a bimodal distribution at the extremes of the OHI scale. Kernel distributions were generated using the geom_violin function in the ggplot package in R Studio with default parameters (kernel = "gaussian", bw = "nrd0", scale =. "area"; R Core Team 2013).