A cut-marked and fractured Mesolithic human bone from Kent's Cavern, Devon, UK

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ABSTRACT

An isolated adult human ulna fragment recovered from the 'black mould' layer of Kent's Cavern by William Pengelly in 1866 exhibits a series of stone-tool cut-marks. The specimen has been directly AMS ^{14}C-dated to 7314–7075 cal BC (OxA-20588: 8185 ± 38 BP), and may be from the same individual as a maxilla fragment dated to the same period. The cut-marks are located on the olecranon process, in a position indicative of dismemberment, while the fracture characteristics of the bone furthermore suggest peri-mortem breakage, typical of butchery for the extraction of marrow. We here present and discuss the specimen, and consider both ritual mortuary treatment and anthropophagy as possible explanations. While it is difficult to interpret a single element in isolation, the latter scenario seems to be better supported, and is not without parallel in prehistoric Europe, as indicated by a review of the available literature.

Located near Torquay on the Devon coast of southwest England, Kent's Cavern (Figure 1), is best known for yielding the earliest anatomically modern human bone currently identified in Britain (Higham *et al*., 2011; Jacobi and Higham, 2010), and for its Quaternary sedimentary record and its large Pleistocene faunal assemblage, representing multiple glacial and interglacial periods (Bocherens *et al.*, 1995; Campbell, 1977; Campbell and Sampson 1971; Garrod, 1926; Keen 1998; Lundberg and McFarlane, 2007; McFarlane and Lundberg, 2005). In addition to the Palaeolithic human maxilla, the cave has also produced Mesolithic human remains, with a maxilla dated to 7308–6698 cal BC (OxA-1786: 8070 ± 90 BP, Hedges *et al*., 1989), and it is this period that forms the focus of this paper. Small numbers of fragmentary human remains have been and continue to be identified amongst the large faunal assemblage from Kent's Cavern. Among the most recent discoveries is that of a proximal adult human ulna bearing a series of fine cut-marks on its proximal end. An initial examination by hand lens indicated that the cut-marks were ancient, and likely to have been made by a stone tool. This provided the impetus for a more in-depth study, the results of which are presented here (expanding on a brief earlier report in Chandler *et al*., 2009). We describe the element and the results of detailed visual examination, and present an AMS determination placing it within the early part of the British Late Mesolithic. We also present a new result for the previously dated maxilla, indicating that the two elements are contemporary in radiocarbon terms and may refer to the same individual. Interpretation of the cut-marked ulna in the wider context of Mesolithic Europe considers two main – though not mutually exclusive – possibilities: ritual dismemberment and anthropophagy/cannibalism.

THE SITE

The extensive cave system of Kent's Cavern, Torquay, Devon (50.4670° N, 3.5034° W; 60m OD) was created by dissolution of the Middle-Upper Devonian Limestone that formed in a warm shallow sea around 390-360 million years ago (Lundberg and McFarlane, 2008). The karst system consists of two parallel sets of chambers linked by interconnecting chambers or fissures, in total extending over approximately one kilometre. It records continuous, repeated sedimentation events, punctuated by frost shattering that track all the major climatic cycles over 500,000 years, possibly making the cave unique in a European-wide context (Lundberg and McFarlane, 2007). The cave currently has two entrances situated about 15 metres apart. The North Entrance leads onto the Vestibule, and Sloping Chamber, while the South Entrance leads to the Great Chamber, connecting through the Passage of Urns to the Sloping Chamber and Vestibule (Figure 2). These two entrances would have provided access to the cave throughout the Holocene, as is evident in the archaeology of the uppermost sedimentary layer that filled the most accessible areas of the cave, with many different prehistoric and historic periods represented.

William Pengelly's excavation of the 'black mould'

Earlier visits aside, Kent's Hole (as it was originally known) has been the subject of scientific investigation since Northmore's search for a 'Mithratic Cavern' brought him to the cave in 1824 (Pengelly, 1868; 1885). Father John MacEnery first recorded the true nature of the deposits during intermittent excavations between 1825 and 1829, from which he recovered flint tools *in situ* below the stalagmite on the cave floor (MacEnery, 1859), fueling the vigorous debate between religious and secular scientists on the 'antiquity of Man'. Indeed, many of these debates came to be held in the Torquay Museum, founded in 1845. For the purposes of this paper, however, the excavations of principal importance are those conducted by William Pengelly between September 1864 and August 1879. Pengelly applied to Kent's Cavern the excavation techniques he first trialed at Brixham Cave between 1858-59. The task at Kent's was considerably more complex, as the sheer size of the cavern and the width of the chambers required an excavation system that was truly three-dimensional in its scope (McFarlane and

Lundberg, 2005). His solution to this problem would become a cornerstone of modern scientific archaeological investigation, with its first application to the uppermost 'black mould' layer of Kent's Cavern (Warren and Rose, 1994). Writing in 1865, Pengelly's manuscript diaries record his excavation technique.

A line, termed the "Datum Line" or "Datum" was stretched horizontally from a fixed point on the external face of the masonry at the Entrance to another point at the back of the Great Chamber, and intersecting at right angles the section which had been cut as described above. The direction of this line, carefully ascertained by compass was W.5˚N. magnetic: Lines one foot apart are to be drawn at right angles to the Datum line, and therefore parallel to one another, across the Great Chamber so as to divide its surface into belts, termed "foot-parallels" or "parallels".
In each Parallel the Black Mould between the large masses of Limestone is to be carefully examined in situ, and then taken to the Entrance of the Cavern for re-examination in full daylight.
(Pengelly, 1863-1868, 10)

Pengelly believed the sediments of the 'Black Mould' represented some 1500 to 2000 years of time. The exact composition of this layer has never been determined, but it certainly contained charcoal, ash, decayed organic material, leaf fall, shells, animal and human bone and a range of artifacts principally spanning the Mesolithic to the Romano-British and medieval periods – though none of the directly dated fauna has yet yielded a Mesolithic result. The black mould formed a layer 3-12 inches (0.1-0.3m) in thickness lying between and beneath limestone blocks (Pengelly, 1866). The excavation technique described above was employed slightly differently to the black mould and granular stalagmite than the lower strata of the cave. In the cave earth for example, a prism of sediment 1 foot by 1 foot by 1 yard was given an individual context number, but in areas of the black mould groups of parallels were removed and given a single context number. During Pengelly's sixteen seasons of excavation he would remove this layer in its entirety, leaving only isolated fragments embedded in the walls of the Great Chamber (C. Proctor, pers. comm.). Between Tuesday 25th and Friday 28th September 1866, workmen in the Sloping Chamber removed the 34th to 46th parallels of black mould (an area of approximately 4.2 m^2 by up to 0.3m depth). Items found included charcoal, pebbles, a whetstone, pieces of slate, a perforated stone and various shells (Pengelly 1866). Unrecognized by the workmen among several hundred pieces of bone were human remains including the fragmentary human ulna that is the focus of this paper.

THE ULNA

The proximal third of an adult right ulna (Torquay Museum A6473) was found in Pengelly's excavations at Kent's Cavern (Pengelly no. 1774, 28/09/1866), and, as noted above, can be attributed to the 'black mould' in the Sloping Chamber near the front of the cave system. It was recognized by one of the authors (BC) amongst the large faunal assemblage from the site that is still being documented and analysed. The element is very well-preserved, with sound cortical surfaces lacking any weathering damage, and is of an average size and robusticity. Its surviving length is 94.8 mm, with a maximum medio-lateral width of the olecranon process of 21.5 mm (Figure 3). The fragment is insufficiently complete to determine sex. The impetus for the present investigation came from the presence of a series of fine cut-marks observed on the proximal end (Figure 4).

Detailed examination of the interior surfaces of the cut-marks is made difficult by the liberal application of a consolidant, seen on much of the Kent's Cavern bone assemblage. Thus, the use of scanning electron microscopy is not possible at present, and the element was initially analyzed using a hand lens and binocular microscope (Chandler *et al.*, 2009). The more detailed analysis presented here uses an Alicona InfiniteFocus optical surface measurement system (Bello and Soligo, 2008; Bello *et al.*, 2009) to produce detailed three-dimensional models of the humanly modified surfaces (lens 2.5x, vertical resolution 9.0 μm and lateral resolution 1.65 μm; lens 5x, vertical resolution 999 nm and lateral resolution 1.49 μm). Three clusters of slicing cut-marks are present on the posterior border of the proximal end of the ulna, all transversally oriented to the bone's main axis. All are well-patinated, with some continuing under adhering sediment; therefore, none can be attributed to excavation or post-excavation instrument damage. Their micromorphological features are consistent with incisions made by a stone tool, being relatively wide compared to cuts made by a metal edge, and showing clear examples of double parallel lines (Andrews and Cook, 1985; Behrensmeyer *et al.*, 1986; Bello and Soligo, 2008; Boulestin, 1999; Domínguez-Rodrigo *et al.*, 2009; Greenfield, 1999; Shipman, 1981; Shipman and Rose, 1983; White, 1992).

Beginning at the proximal end, the first cluster consists of four sub-parallel cut-marks located just below the olecranon process. They are generally short (about 3-4 mm), large (average width at surface level of 176 μm) and with an average depth (taken at the mid-point of each cut) of about 40 μm. Their V-shape cross-sectional profiles suggest that they were made by a stone tool held almost perpendicular to the bone surface, the angle of tool impact (Bello and Soligo, 2008) having an average inclination towards the bone surface of about 82° (Figure 5). A second cluster of four cut-marks is located about 0.5 cm distal to the first, but towards the medial part of the ulna. These cut-marks are also short (2-3 mm) and sub-parallel to each other, but slightly narrower (average width at surface level of 136 μm) and shallower (average depth taken at the mid-point of each cut of 29 μm) than those of the first group; two are extremely shallow, less than 20 μm, and are better classed as superficial scratches rather than slicing cut-marks. This second cluster of four cut-marks all present a neat V-shape cross-section, the angle of tool impact being almost perpendicular to the bone surface (with an average inclination of ca. 86°; Bello and Soligo, 2008). The final cluster is located about 14 mm distal to the second cluster at the mid point of the olecranon process. It consists of two longer (~ 6mm) cuts with micro-morphological characteristics very close to those observed for the cut-marks forming the first cluster: width about 200 μm, depth 43 μm and average inclination of the tool being about 82°. These cut-marks are partially covered by adhering $CaCO_3$ sediment. The cross-sectional profiles of all analysed cuts indicate that they were made with the tool held almost perpendicular to the bone surface, suggesting a cutting rather than a filleting action (Bello *et al.*, 2009; 2011). The microscopic identification of Hertzian cones along these cut-marks would indicate that that they all have the same direction (Bromage and Boyde, 1984) with a starting point on the lateral aspect of the olecranon process. Considering the directionality and the evaluated inclination of the angle of the tool impact, it is likely that the tool was used by a right-handed person (Bermúdez de Castro *et al*., 1988; Bromage and Boyd, 1984; Pickering and Hensley-Marschand, 2008).

The cut-marks are all found on the flat, elongated triangle of bone forming the posterior of the olecranon. While various muscle groups attach to the very top of the process, and to either side, the triangle itself is covered by a subcutaneous bursa, a small sac composed of fibrous tissue and filled with synovial fluid, providing a cushion between the bone and the muscles surrounding a joint, in this case the elbow (Gray, 1977 [1901]). Presumably, the cuts were made to remove superficial tissues and to cut through the bursa to facilitate separation of the forearm.

In addition to the cut-marks described above, a notch on the ulna's medial surface, just below the coronoid process, exhibits all of the characteristics of an impact point made on fresh bone, with patinated internal bevelling forming part of a percussion cone (Figure 6) (Boulestin, 1999; Blumenschine and Selvaggio, 1988; Knüsel and Outram 2006; Pickering and Egeland, 2006; Villa and Mahieu, 1991; Turner and Turner, 1999; White, 1992). As a result of this impact, the ulna as a whole is fractured lengthwise from the trochlear notch, continuing down the anterior surface before terminating in a sharp point (Figure 7). The fracture is spiral, with smooth surfaces, both features being strongly suggestive of peri-mortem breakage (cf. Knüsel, 2005; Knüsel and Outram, 2006; Outram, 2002; Villa and Mahieu, 1991; Wheatley, 2007). Taken together, the impact point and fracture margins indicate that the ulna was intentionally struck and split while still fresh, either with a heavy stone tool or simply an unmodified cobble. While there is no direct relationship between the cut-marks and the fracture (e.g., no cut-marks terminate into a fracture edge), it is highly probable that the forearm was first removed by cutting with a fine stone blade through the main muscles, tendons and other tissues attaching it to the humerus, and then struck with a heavier stone implement to split it.

With confirmation that the cut-marks were caused by a stone tool, a prehistoric age for the ulna would be expected. But given the lack of any reliable stratigraphy or archaeological associations, and the wide range of dating evidence for human remains in Kent's Cavern (Chandler *et al.*, 2009; Hedges *et al.*, 1989; 1991; 1996; Jacobi *et al.*, 2006; Silvester, 1986; Tuross, 2003), direct radiocarbon dating was the only means of determining the element's age more precisely. We turn to this now.

RADIOCARBON DATING AND STABLE ISOTOPE ANALYSIS

A small sample of bone was removed from the medullary cavity of the Kent's Cavern ulna (A6473). Because of the liberal use of a consolidant (probably PVA) on much of the assemblage, including the ulna, the area was first mechanically cleaned. Following this, the bone was sampled using a tungsten carbide drill, removing bone powder weighing 360 mg. The powder was treated with sequential solvents, including methanol, designed to mobilise and thereby remove any consolidants. Bone collagen was then extracted by decalcification with 0.5M HCl, followed by an 0.1M NaOH wash, and a re-acidification using 0.5M HCl. Between each step a distilled water rinse was applied. The collagen was gelatinised in weakly acidic pH3 water at 75°C in an incubator for 20 hours. The supernatant was recovered using an EziFilter™. The gelatin was then ultrafiltered using a Vivaspin™ 30 kD MWCO ultrafilter (see Bronk Ramsey *et al.*, 2004a; Higham *et al.*, 2006) and the >30 kD fraction freeze-dried. We extracted 25 mg from the bone sampled, a yield of 7% by weight, indicating that the bone is well-preserved. The ultrafiltered gelatin was then combusted, graphitised and AMS dated after Bronk Ramsey *et al.* (2004b). We feel confident that the contaminant was removed using these methods, and that the estimate discussed below reflects the true age of the specimen.

The sample provided an ^{14}C AMS determination of 8185 ± 38 BP (OxA-20588: 7314–7075 cal BC at 95% confidence), placing it within the early part of the British Late Mesolithic. The $\delta^{13}C$ value of -19.7‰ indicates little or no appreciable consumption of marine protein in the diet of this individual, and so no correction for a marine reservoir effect is necessary. The slight elevation (of ca. 1‰) compared to a purely terrestrial endpoint appears to be typical of early Holocene human and faunal remains in Britain, even in inland locations such as Aveline's Hole, Somerset (Schulting, 2005; see also Richards and Hedges, 2000). While Kent's Cavern is currently less than 500m from the coast, sea levels would have been some 20m lower at ca. 8000 ^{14}C years BP (Heyworth and Kidson, 1982), so that the coast would have been a few kilometres distant. Nevertheless, the absence of clear isotopic evidence for the consumption of marine foods is surprising, given the findings from this period at Caldey Island in south Wales (Schulting and Richards, 2002). The $\delta^{15}N$ value of 10.2‰ is moderately high, but not sufficiently so to suggest a reliance on freshwater fish (e.g., G. Cook *et al.*, 2001), nor would this be expected to be a major resource in this part of Devon (i.e., there are no major river or lake systems in the immediate vicinity). Both isotope values are averages of measurements run in triplicate on a SerCon mass spectrometer. The C:N ratio of 3.4 is within the accepted range for *in vivo* collagen (DeNiro, 1985).

A list of the directly dated human elements from Kent's Cavern is provided in Table 1. These include a number of specimens from the 'black mould' in the Sloping Chamber near the entrance, in which the ulna was found, though most of these have been dated to Neolithic and later periods. Interestingly, the new determination from Kent's Cavern falls very close to the previously reported result of 8070 ± 90 BP (OxA-1786: 7308–6698 cal BC) on a human maxilla (Hedges *et al.* 1989). In order to confirm their near-contemporaneity, a new measurement was made on this maxilla, in the light of advances in pre-treatment and the higher precision now available (Brock *et al.*, 2007; 2010; Bronk Ramsey *et al.*, 2004b). The new result of 8270 ± 45 BP (OxA-23812: 7478–7145 cal BC) is closer to the date for the ulna, and differs significantly from the previous determination on the maxilla (χ^2, T = 3.9 (5%, 3.8) (Ward and Wilson, 1978)). OxA-1786 is therefore now replaced by OxA-23812; as a heuristic exercise, the latter and OxA-20588 on the ulna may be combined to 8221 ± 30 BP (7344–7083 cal BC; χ^2, T = 2.1 (5%, 3.8). It is thus conceivable that they belong to the same individual, though the two specimens demonstrate very different appearances, with the maxilla fragment coloured white and partially covered in a stalagmite concretion (Figure 8). Nevertheless, both are recorded as deriving from the 'black mould' layer near the entrance of the cave system (the ulna from the Sloping Chamber, and the maxilla from the Vestibule – artefacts and AMS-dated fauna both confirm a Late Upper Palaeolithic presence in the black mould layer, as well as later material (Hedges *et al.*, 1991; 1996)). Most recently, the former includes a determination of 12308 ± 39 BP (12922–12046 cal BC, from combined repeat results on the same specimen: OxA-23816, 12265 ± 55 BP and OxA-23817, 12350 ± 55 BP) on a red deer humerus displaying a spiral fracture (Figure 9).

The δ^{13}C and δ^{15}N values for the human maxilla, -19.3‰ and 10.2‰, respectively, do not differ significantly from those obtained on the ulna, and so are not inconsistent with their attribution to the same individual. The absence of any other dated Mesolithic human remains from the site suggests that, unlike Aveline's Hole in Somerset (Schulting, 2005), Kent's Cavern was not a major burial site for the period. Other determinations on isolated human bones from the black mould of the Sloping Chamber refer to the Early Neolithic (ca. 3800 cal BC), Early and Late Bronze Age (ca. 1800 and 1200 cal BC, respectively), Anglo-Saxon (ca. cal AD 400-600) and medieval period (ca. cal AD 1300-1400) (Table 1).

DISCUSSION

Human remains dating to the Mesolithic are comparatively rare in Britain (Meiklejohn *et al.*, 2011), making the placement of the Kent's Cavern ulna in this period of some interest in its own right, though of course this is severely limited by its being a single element, partial at that, without any contextual associations. The closest find in terms of age, aside from the abovementioned maxilla, is an isolated clavicle fragment from Oreston Cave, Devon (Chamberlain, 1996). A much larger assemblage of Mesolithic human remains comes from Aveline's Hole, Somerset, with early reports of as many as 50 or more skeletons, of which fragments of at least 21 individuals survive (Schulting, 2005). These have been dated to ca. 8300 cal BC (Marshall and van der Plicht, 2005). When taken together with Mesolithic human remains from caves and rockshelters in south Wales (Schulting and Richards, 2002; Schulting, 2009), south-west Britain clearly emerges as a comparatively rich area for human skeletal remains of this period (see summary in Meiklejohn *et al.*, 2011). This is presumably due in large part to a combination of the presence of suitable burial contexts (caves), good preservation conditions (the band of limestone running through the area), and a long history of research.

Despite being limited to a single element, the Kent's Cavern ulna takes on considerably more importance through the presence of cut-marks and peri-mortem fracturing, both of which, while far from unknown, are relatively rare in British, and indeed European, prehistory (none have been identified in the Mesolithic sites mentioned above). It is their co-occurrence on the ulna that is particularly interesting, and may shed some light on the circumstances involved.

It is unusual to find evidence of peri-mortem breakage to limb bones, as opposed to peri-mortem cranial fractures, usually interpreted within a context of interpersonal violence (e.g., Schulting and Wysocki, 2005). Aside from issues of identification (see Knüsel, 2005; Knüsel and Outram, 2006; Villa and Mahieu, 1991), interpretation of post-cranial peri-mortem fracturing is fraught with difficulties when dealing with human remains, not least because it raises the highly contentious issue of anthropophagy. The criteria for acceptance become that much more stringent, compared with that for the butchery of animals (Turner and Turner, 1999; White, 1992). There is no convincing evidence for burning on the Kent's Cavern ulna, nor of so-called 'pot polish' (abrading of the broken ends of long bones though contact with unglazed pottery during cooking) on the fracture margins, though of course both these criteria depend on the treatment of the element after breakage (and, in the latter case, on the presence of pottery, which did not form part of the material culture repertoire of the British Mesolithic). Cut-marks can be, and usually are, interpreted as post-mortem ritual treatment of the dead (e.g., Auboire, 1991; Wakely in Evans and Hodder, 2006, 147-148; Cauwe, 1998; McKinley, 2008; Murphy, 2003; Smith and Brickley, 2004; Smits and van der Plicht, 2009; Toussaint, 2011). Peri-mortem fractures could conceivably occur by accident, such as by a rockfall. However, the coincidence of cutmarks and peri-mortem breakage arguably provide a context more suggestive of processing of the corpse for consumption (cf. Villa *et al*., 1986, 431). While the main alternative, of post-mortem ritual defleshing, provides an equally valid (indeed, perhaps more so) interpretation for the cut-marks, it is less clear why intentional splitting of the bone should follow in this scenario. It is not inconceivable that ritual processing would take this further step; indeed, fracturing of human bone for the removal of marrow – without consumption – as part of the funerary rite has been reported from Aboriginal Australia (Pickering, 1989; 1999). Whether such an interpretation can be applied in the European context is another question, one to which we return below. Although it is still comparatively rare, there is far more evidence for cut-marks relating simply to disarticulation and/or defleshing (see sources cited above). Furthermore, the former practice need not necessarily leave traces on the bones, particularly if the body were already fully or partly decomposed and could be disarticulated with minimal need for cutting. La Chaussée-Tirancourt (Somme), northeast France, provides a clear example of a secondary burial rite dating to the Early Mesolithic, with the long bones laid side by side in a pit in a bundle-like arrangement, surmounted by the skull (Ducrocq *et al.*, 1996).

There are wider British and European comparanda upon which to draw for the co-occurrence of cut-marks and peri-mortem fracturing. The first point of comparison with the Kent's Cavern ulna is the human bone assemblage from Gough's Cave, Somerset, some 110 km northeast of Kent's Cavern (Figure 1). Although it is considerably earlier, dating to the Late Upper Palaeolithic, ~14,700 cal BP (Jacobi and Higham, 2009), this period shares with the Kent's Cavern find both a hunter-gatherer way of life and general geographical proximity. Cut-marks are present on a number of adult and subadult elements at Gough's Cave, both cranial and post-cranial. The nature of the assemblage has been debated, with Cook (1986; 1991) accepting very few of the cut-marks and preferring to suspend judgment regarding their interpretation. In contrast, Andrews and Fernández-Jalvo have presented a case for cannibalism, pointing to the similar treatment of the human and faunal remains, to the occurrence of peri-mortem fractures as well as cut-marks, and to the presence of what they interpret as human tooth-marks (Andrews and Fernández-Jalvo, 2003; Fernández-Jalvo and Andrews, 2011). The most recent study follows in this vein, highlighting the frequency of cut-marks and intentional fracturing on the crania, suggesting a fairly elaborate and specific post-mortem treatment intended to produce something akin to 'skull cups' (Bello *et al.*, 2011), though whether and, if so, how they were actually used is unknown. Of more direct relevance here is the occurrence of cut-marks on the postcranial remains from Gough's Cave, including two ulnae. While their location does not match those on the Kent's Cavern ulna, percussion pits can be observed in a similar anatomical location on the same two specimens with cut-marks (Figures 10 and 11).

In a wider northwest European Mesolithic context, there are a number of sites where cut-marks have been identified on human remains. For the most part, the interpretation of these has tended to favour ritual defleshing and dismemberment, as a means of hastening the process of transformation from a fleshed corpse to disarticulated skeletal remains. The underlying rationale for this is, in turn, typically viewed as speeding the process of joining the 'ancestors', however these are to be defined (see Whitley, 2002), a notion and practice that is more often thought of in conjunction with Neolithic farmers (Barrett, 1994; Thomas, 1999). There are, however, two examples of northwest European Mesolithic sites where the issue of cannibalism has been raised: Dyrholmen in Denmark (Degerbøhl, 1942), and La Grotte des Perrats à Agris in France (Boulestin, 1999). Little can be said about Dyrholmen, as there has been no re-analysis of the skeletal assemblage, and many of the criteria for the identification of cannibalism – or even peri-mortem fracture – were undeveloped at the time. La Grotte des Perrats à Agris differs in being a more recent excavation and analysis. The site includes a relatively large commingled assemblage of human and animal bone, dated to ca. 7000 cal BC. Both the faunal and human remains present evidence of burning together with cut-marks and peri-mortem fracturing (Boulestin, 1999; Boulestin and Gomez de Soto, 1995). The human remains represent at least eight individuals, including five adults and three children. They show cut-marks and peri-mortem fracturing to both crania and post-crania, with the former including injuries interpreted as being the probable cause of death for some individuals. Cut-marks and percussion marks occur on a number of ulnae (Boulestin, 1999, plates XXXIV–XXXVI), with one of the latter being in a similar position to that seen on the Kent's Cavern specimen (ibid., fig. 61).

Casting the chronological net slightly wider, there are also cases to be made for the Neolithic period. Dating to ca. 5200–5000 cal BC, the Early Neolithic site of La Grotte du Gardon (Ain), France, held the very partial remains of a man, a woman and a child, found mixed together with faunal remains, with both showing traces of burning, cut-marks and intentional fracturing (Chaix *et al.*, 1991). Similar evidence has been found at Fontbrégoua (Salernes), southern France (Villa, 1992; Villa *et al.*, 1986). While Boulestin (1999; see also Boulestin and Gomez de Soto, 1995) raises some reservations concerning the details at this site, he does still concur that cannibalism likely occurred there, in a ritual context. More controversial claims for mass cannibalism have been made for the Early Neolithic (ca. 5000 cal BC) enclosure of Herxheim, Germany (Boulestin *et al.*, 2009), with Orschiedt and Haidle (2007; 2012) arguing that the fractured and cut-marked remains represent post-mortem ritual treatment of the dead. Early suggestions of cannibalism made for the Late Neolithic Pitted Ware Culture site of Jettböle (3370–2840 cal BC), Åland, Sweden, have, despite initial skepticism, been supported in a recent re-analysis (Nuñez and Líden, 1997). As at La Grotte des Perrats à Agris, a strong case can be made at Jettböle, since the human and animal remains show similar treatment – bearing traces of burning, cut-marks, and peri-mortem fracturing – and were found scattered together in a midden deposit (cf. Turner and Turner, 1999). While nominally Neolithic, the subsistence economy of Pitted Ware groups was strongly based on seal hunting, with minimal contribution from domestic plants and animals, so that they have more in common with earlier Mesolithic lifestyles than with Neolithic farmers present across much of Europe at this time, including elsewhere in southern Scandinavia (Nuñez and Líden, 1997).

A key point in a number of the above studies is the similar treatment of human and animal bone, both in terms of traces of butchery, and of final deposition. It is this similar treatment and seemingly casual disposal of human and animal remains that present a more convincing case for anthropophagy, and would seem to weigh against a funerary rite that involved both disarticulation and splitting of the bone, as has been raised as an alternative interpretation by

Pickering (1989) based on the occurrence of this practice in Aboriginal Australia. Unfortunately, the nature of the Kent's Cavern material precludes a direct comparison of the human and animal remains.

The point of the above examples is to demonstrate that, while evidence for anthropophagy in the prehistoric European archaeological record is rare, it is not entirely absent (nor do the above examples constitute a comprehensive survey). Thus, the interpretation of the ulna from Kent's Cavern in this context would not be without precedent. Indeed, given the stigma attached to cannibalism, and the reluctance of many researchers to entertain it without overwhelming proof (e.g., Arens, 1979; Bahn, 1990) – in marked contrast to the antiquarian enthusiasm for prehistoric cannibalism, commented upon for example by Brothwell (1961) – it may be suggested that the practice was rather more widespread than the current evidence would suggest (cf. Taylor, 2003). But even if accepted, this in itself says little about the all-important reasons behind it. The fact that evidence for the butchery of human remains is not more widespread in prehistoric Britain (and Europe in general) indicates that such occurrences were rare and were not part of typical funerary behaviour, and certainly not a normal aspect of subsistence, as recently suggested for Lower Palaeolithic Europe by Carbonell *et al.* (2010). This would seem to weigh against an interpretation of ritual cannibalism as a normative practice, and suggests instead a context of transgression. Starvation cannibalism can occur *in extremis*, and presents one possibility. One could also envisage a scenario of punishment for the breaking of social taboos, or an insult dealt to an enemy. Conversely, anthropopaghy can also occur as a mark of respect for the dead, usually one's own relatives (i.e., endo- versus exo-cannibalism). Evidence for all of these practices and others can be found in the ethnographic records of the band and tribal-level societies that provide the best, even if far from perfect, analogues for earlier prehistoric Britain (Bishop and Lytwyn, 2007; Bowden, 1984; Brown and Tuzin 1983; Conklin, 2001; de Castro, 1992; Forsyth, 1983; Goldman, 1999; Petersen and Crock, 2007; Sanday, 1986; Zegwaard, 1959). Caves as liminal spaces (Barnatt and Edmonds, 2002; Leach, 2008) may have presented especially appropriate locations for such non-normative behaviours, recalling the evidence for modified human remains from Gough's Cave. But in the end the ulna is, at present, an isolated find, and can provide only limited, if intriguing, insights.

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Sample	*Context*	*Element*	*Lab no.*	^{14}C *BP*	±	*cal BC/AD 95%*		$\delta^{13}C$	*Reference*
0.309	Vestibule	maxilla	OxA-1621	30900	900	35906	31633	-	Hedges *et al*., 1989
0.309	Vestibule	maxilla		37–35 ka BP		44.2–41.5 cal BP			Higham *et al.*, 2011
A6473	Sloping Chamber	R ulna	OxA-20588	8185	38	7314	7075	-19.7	this paper; Chandler *et al*., 2009
A2540	Vestibule	maxilla	OxA-1786	8070	90	7308	6698	-	Hedges *et al*., 1989
A2540	Vestibule	maxilla	OxA-23812	8270	45	7478	7145	-19.3	this paper
A6645	Sloping Chamber	L ulna	OxA-23809	5053	29	3952	3783	-20.7	this paper
A5885		mand tooth	OS-36644	5020	45	3947	3708	-18.2	Tuross, 2003
		cranium	OxA-1787	3560	70	2131	1695		Hedges *et al*., 1989
A5884		mand tooth	OS-36643	3460	40	1890	1684	-17.8	Tuross, 2003
A6643	Sloping Chamber	R radius	OxA-23810	3008	26	1378	1131	-21.8	this paper
KC 5		ulna	OxA-13132	1520	90	AD 341–666		-19.6	this paper
KC 6		mandible	OxA-11783*	570	24	AD 1309–1419		-17.7	this paper

Table 1. Radiocarbon dated human remains from Kent's Cavern. NB: OxA-11783 is subject to possible ultrafilter contamination (Brock *et al*., 2007; 2010), but should be broadly correct. OxA-1621 is considered a significant underestimate of the real age of this specimen, which Higham *et al.* (2011) have recently suggested is better placed at ca. 44.2–41.5 ka cal BP. Calibrated with OxCal v4.1, using IntCal09 (Reimer *et al*., 2009).

Figure captions

Figure 1. Map showing location of Kent's Cavern and sites with Late Upper Paleolithic and Mesolithic human remains in southwest Britain. The coastline at ca. 8000 ^{14}C years BP (ca. 7000–6850 cal BC) would have been about -20m lower than at present.

Figure 2. Plan of Kent's Cavern; the ulna was found in the 'Sloping Chamber'. From survey by Chris Procter.

Figure 3. Right proximal adult ulna from Kent's Cavern (Torquay Museum A6473). Photo: R. Schulting.

Figure 4. Proximal end of ulna showing series of cut-marks; scale bar 1 cm. Photo: R. Schulting.

Figure 5. First cluster of cut-marks on the Kent's Cavern ulna, Alicona InfiniteFocus optical surface measurement system, 2.5x magnification; scale bar 1 cm. Image: S. Bello.

Figure 6. Impact point on Kent's Cavern ulna, with Alicona InfiniteFocus optical surface measurement system, 2.5x magnification; scale bar 1 cm. Image: S. Bello.

Figure 7. Smooth fracture surfaces on the Kent's Cavern ulna. Photo: R. Schulting.

Figure 8. Human maxilla fragment from Kent's Cavern, directly dated to the Mesolithic. Photo: R. Schulting.

Figure 9. Red deer humerus (P8299) from the black mould layer in the Sloping Chamber, exhibiting a spiral fracture. Dated to 12922–12046 cal BC (95% probability). Photo: R. Schulting.

Figure 10. Locations of cut-marks (red lines) and impact points (black arrows: percussion damage; white arrows: anvil scars) on the Kent's Cavern and Gough's Cave ulnae. Image: S. Bello.

Figure 11. Percussion pits on Gough's Cave ulna. Photo: S. Bello.