

‘... PURSUING A RABBIT IN BURREINGTON COMBE’:  
NEW RESEARCH ON THE EARLY MESOLITHIC BURIAL CAVE  
OF AVELINE’S HOLE

by

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With contributions by the following

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ABSTRACT

The main focus of this paper is the re-analysis of the fragmentary human skeletal assemblage from Aveline’s Hole. A brief history of the site’s discovery and excavation is presented. A minimum of 21 individuals can be identified in the extant collection, including both sexes and a wide range of ages from neonatal to older adult. Some stress markers are evident in the form of cribra orbitalia, linear enamel hypoplasia and Harris lines. Evidence for other pathologies is very limited, in part no doubt due to the poor preservation and representation of articular ends of longbones and vertebrae. Dental pathology is also low, with caries occurring on only one individual in the surviving assemblage. Interproximal grooves are present on a number of molars, and striations are also seen on some anterior teeth relating to non-dietary activities. Dental microwear analysis examines the occlusal wear on a number of molars in greater detail, provisionally suggesting a softer diet and more important role for plant foods than might have been expected for hunter-gatherers in a north-temperate environment. Stable carbon and nitrogen isotope analysis of 18 individuals shows no secure evidence for any consumption of marine foods, with implications for seasonal and lifetime mobility of the population using Aveline’s Hole. In apparent contradiction to the microwear findings, stable nitrogen values are high relative to contemporary fauna and suggest high consumption of animal protein. However, the two methods of palaeodietary analysis operate at very different time-scales, and also may emphasise different foods. Strontium isotope analysis suggests that most individuals interred at the site were drawn from the Mendips and its surrounding area, though some movement to the Chalk Downs may be indicated. AMS dating results further confirm an Early Mesolithic (10000-8500 BP) attribution to the burials, and in fact place the use of the site as a cemetery within a surprisingly brief period, between 8460 and 8140 cal BC, with a good probability that use was concentrated within a period of only 70-180 years. A brief discussion of the surviving faunal assemblage is also presented, including some new findings not noted in the original reports. Attempts to extract pollen from sediment in the medullary cavities of four long bones were partly successful, and the results consistent with an open pine-birch woodland in the area near the time of burial. The same sediments were analysed to determine their origin, which was found to be local to the cave

environment. Finally, the wider significance of the site is discussed, with a tentative proposal that increased territoriality relating to rapidly rising sea levels in the early Holocene may be implicated.

## INTRODUCTION

(R. Schulting)

This paper presents the results of a re-analysis of the surviving collections from Aveline's Hole, Burrington Combe, Somerset. The main focus is on the human remains, including new AMS dates and stable isotope data, but discussion also touches upon the surviving faunal remains as well as sediment and pollen from within human long bone cavities. The main goal is to re-present this important early Holocene site, which stands out as a large Early Mesolithic (conventionally, the period 10000-8500 BP) cemetery, with as many as 50 or more individuals originally present. The assemblage is frustratingly incomplete, but a considerable amount of new information has nevertheless been gained. Discussion at the end of the paper turns more widely to the position of the Aveline's Hole cemetery in the Early Mesolithic of southern Britain.

### *The discovery of the Cave at Burrington Coombe*

Formed of Carboniferous limestone overlying Devonian conglomerates, sandstones and shales, the Mendip Hills of north Somerset comprise an upland area measuring some 40 km by 8 km, and rising to a maximum elevation of 325 m O.D., but averaging considerably less than this (*c.* 210 m O.D.). Aveline's Hole is located on the east side of a steep ravine on the north side of the Mendips, near the small village of Burrington (Figure 1). The cave entrance is close to 100 m O.D. The cave system is at least 46 m in length, averaging about 3-4 m both in width and in height (Davies, 1922, Fig. 17) (Figure 2).

The outline of the discovery of the cave at Burrington Coombe is well known, though there are a number of minor discrepancies, as will become clear. I am grateful to Graham Mullan for bringing the following earliest known account to my attention, placing the discovery of the cave on Sunday 8<sup>th</sup> January, 1797:

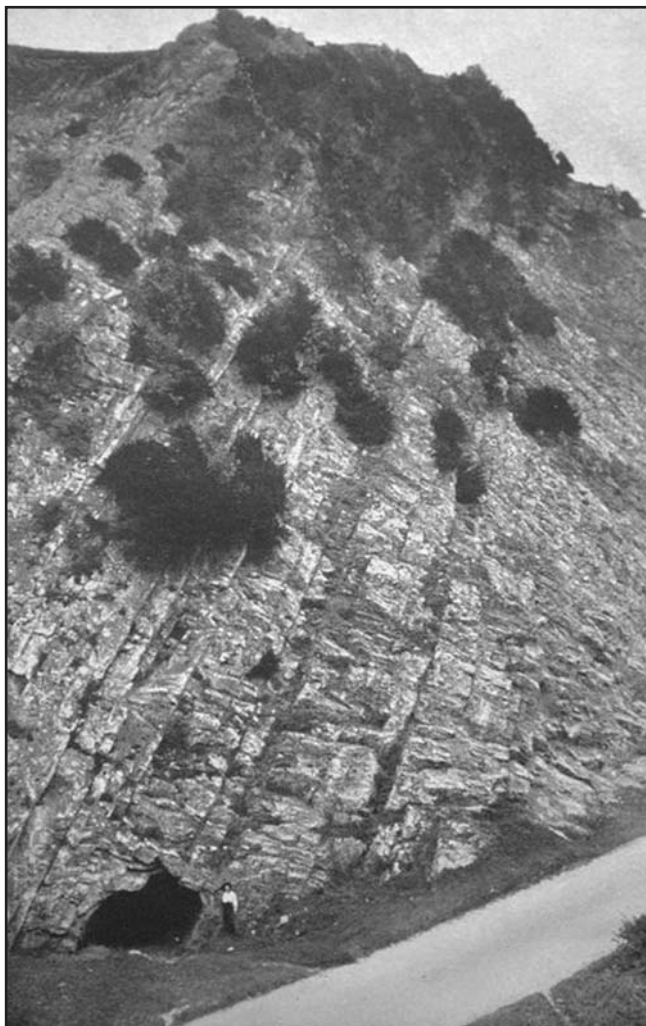
Yesterday sennight as two young men were pursuing a rabbit in Burrington Combe, they observed it take shelter in a small crevice of the rock. Desirous of obtaining the little animal, they with a pickaxe enlarged the aperture, and in a few minutes were surprised with the appearance of a subterraneous passage leading to a large and lofty cavern, the roof and sides of which are most curiously fretted and embossed with whimsical concreted forms. On the left side of the cavern are a number of human skeletons, lying promiscuously, almost converted into stone. (*Bristol Mercury and Universal Advertiser* Volume VII No. 360 for Monday January 16th 1797, p. 3 col. 4).

With the exception of the first two words, this is identical to a letter to the editor of *Sporting Magazine* published later in the same year (Anon., 1797, p. 283). Neither letter is signed, but they are in turn very similar to a passage cited in Davies (1921, p. 61) from the notebook of a Dr. T.S. Walley who lived at Mendip Lodge at the time the cave was discovered.

An even briefer note only seven years later mistakenly dates the discovery of the cave to 1795. It is this account that mentions the finding of 'near 50 perfect skeletons lying parallel

to each other, some of whose bones were petrified' (Wansey, 1805 p. 409). While we can more securely ascribe an author to this note, the antiquarian Mr Henry Wansey, his position *vis à vis* the finders of the cave is unknown. Rutter (1829, pp. 117-118) also places the discovery of the cave in 1795, but he may be referring to the above account.

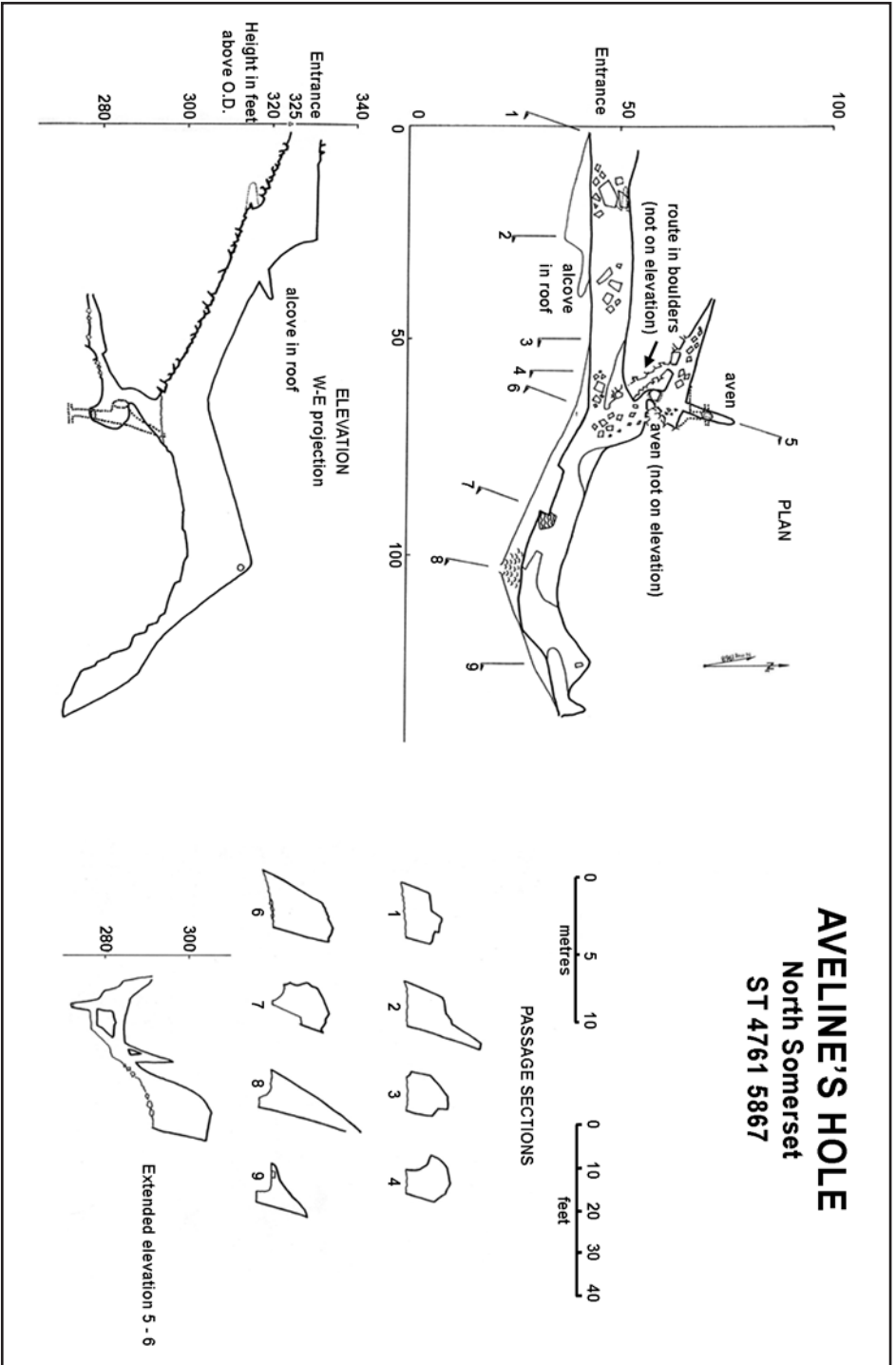
More detailed accounts are given in the unpublished journals of Rev. John Skinner for the years 1819-1824. Skinner was Rector of Camerton, and an enthusiastic antiquarian. He excavated the Priddy Nine Barrows and other sites in Somerset, including a Romano-British site at Camerton itself. He also visited the Avebury area in the company of Sir Richard Colt Hoare, producing many sketches of chambered tombs, barrows, and the finds encountered during their excavations (Grinsell, 1971). Skinner seems to have first visited Burrington Cave in 1819<sup>1</sup> and his account at this time closely matches that given in the *Sporting Magazine* (Skinner, 1819, pp. 106-107):



**Figure 1.** *Aveline's Hole* c. 1921.

As we entered it, he [Skinner's unnamed guide for the day] informed us that the opening in the rock was discovered about twenty years since, by some boys pursuing a Rabbit that took refuge under some larger heaps of stones, piled up to conceal the aperture, which is nearly an arch, three and a half feet high and about six wide. On its discovery, a number of skeletons were seen lying on the left hand side of the Cave about twenty feet from the entrance, several of them being quite perfect, with their heads placed against the rock. Bones of deer and horses were

<sup>1</sup> The cave was not known as Aveline's Hole until named so by Boyd Dawkins in the mid-nineteenth century, in honour of the senior geologist for Somerset, William Talbot Aveline (Cowsh *et al.*, 1962, p. 22; James Aveline Hendrick, *pers. comm.* to Graham Mullan, 2005).



**Figure 2.** Plan and elevations of Aveline's Hole.  
Drawn by R. Stenner, reproduced by courtesy of the Bristol Exploration Club.

also found near the human remains, but no weapons or vessel, as I could learn. On asking whether any of the bones were still to be seen, he shewed us several pieces embedded in the stalactite... (Figure 3).



**Figure 3.** *Sketch of human skeletons in Burrington Cave (Aveline's Hole) by Rev. John Skinner (Skinner vol. XXXV, p. 140).*

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A more detailed entry is found in Skinner's journal of 1824. Here, the basic account is the same, save that the cave was discovered by one man rather than two boys. However, it is the additional detail that is of particular interest. And, for the first time, it is stated that the account was obtained directly from one of the first men to have entered the cave, together with another person whose position in this respect is not made clear (Skinner, 1824, pp. 127-128):

...upwards of 20 years ago, a Burrington man, who was pursuing a Rabbit, suddenly lost his prey among a heap of loose stones piled up against a nearby perpendicular lime stone rock near the road to the left-hand side, as you go up the Coombe... Having made the discovery, he procured assistance, and by clearing away the rubbish in front of a large flat stone which was placed upright to close the mouth of the Cave, the party examined it with lights... they first encountered a large stalactite, six feet in length, suspended from the roof... When struck, the stalactite sounded like a bell, as was the man's expression. On the ground of the Cavern, which measured in the interior about twelve feet in width to upwards of a hundred in length, were deposited skeletons, lying not side by side, but one after the other, their feet pointing towards the opening of the Cavern: one man said he counted twelve of these skeletons perfect: the other said there were twenty: there

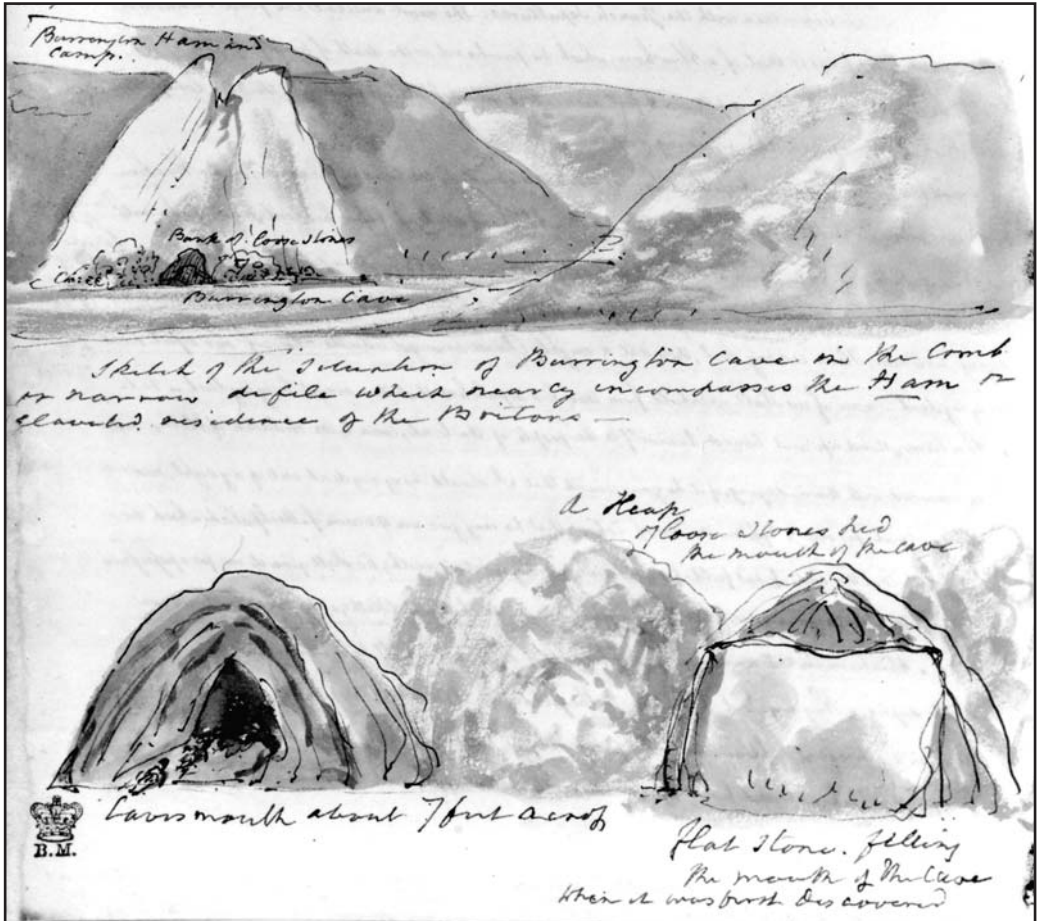
were also bones of horses, but no kind of iron weapon, or earthen vessel of any description. On a closer inspection, they found that other skeletons had been laid near to the left hand side of the Cavern, and were incrustated and almost become a part of the rock, by the dripping of the water upon them.

The most interesting aspect of this account is the description of the large flat stone ‘placed upright to close the mouth of the Cave’. This account is repeated in another of Skinner’s journals, with the addition of a sketch based on the description (Skinner, vol. XXXV, p. 5) (Figure 4). The mention of a stalactite in the cave had been made previously, in 1799, by George Smith Gibbes (1800, p. 144), though he placed it towards the rear of the cave. Surviving indications of a large missing stalactite there today suggest that this is more likely to be the correct location (Mullan *pers. comm.*, 2005). Gibbes also remarked on its musical qualities: ‘On striking this stalactite, a sound is produced similar to that of a bell, which may be heard at a considerable distance beyond the mouth of the cave’. Wherever its original location, there are no comparable stalactites in the cave today, but then this is hardly surprising, given the activities of over two centuries of visitors and relic collectors.

The early visitors to the cave were responsible for great damage to the deposits, through the taking away of souvenirs and ‘specimens’, as Skinner commented (1820, p. 33): ‘Mr Cranch obtained some specimens to take home with him, as the place has been much visited of late, and every visitor taken away with him a piece of the incrustation it will soon be demolished.’ But he was far from blameless himself, although of course this needs to be seen in the context of the time: ‘Before we returned to day light, our conductor procured us some fragments of the bones of a skeleton imbedded in the stalactite, which he knocked off with a large stone; one piece retained two teeth with the enamel quite perfect; another, a fragment of a large bone, probably the thigh bone. ... It is very probable that this Cavern was occupied as a burying place by some of the earliest British settlers...’ (Skinner, 1819, p. 107). In a later visit Skinner took a more active role:

For several days after the discovery was made, persons came from all parts to visit the place, and took away some of the bones with them, till Mr [TS?] Wyld, the Rector of Bxxxx? [Burrington?], had several cart loads of earth thrown over the bones, in order to bury them; but as the sheep are continuously entering the Cavern, these bones are from time to time uncovered: indeed we saw several which had been collected at the entrance, some evidently human; others of Swine, Sheep, and larger animals, either oxen or horses; and one the jaw of a Fox. As I wished much to procure a specimen of the incrustation, I desired the man to dig with his pick axe where he thought he could meet with one; and in the course of a quarter of an hour, he brought me the greater part of a cranium entirely imbedded [sic] in the Stalactite: in getting it out he broke it off from the skull, and I have no doubt but the skeleton might be procured from the same place (Skinner, 1824, p. 128). (Figure 5).

Skinner makes the following final observation on the nature of the site: ‘While observing the heap of rubbish at the entrance, I picked up a bit of flint, cut with the intention of making an arrowhead; and also noticed some small pieces of charcoal: from all of which circumstances, I am convinced that the Cavern was employed as a burying place, probably by the same people who erected the Long Barrows of Fairy Toote, and Cowleys; also that at Stoney Littleton...’ (Skinner, 1824, p. 128).

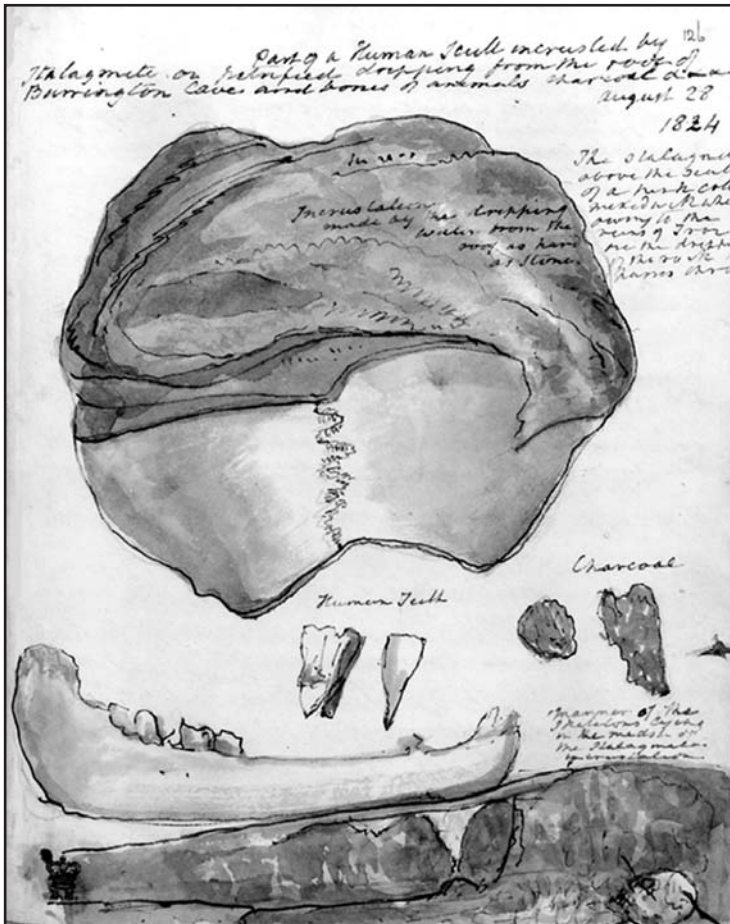


**Figure 4.** Sketch by Rev. John Skinner showing a view of the slab (lower right) reported to have been found sealing the mouth of Burrington Cave (Aveline's Hole) upon its discovery (Skinner, 1824, p. 5).

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#### *The University of Bristol Speleological Society excavations*

Undoubtedly many people visited the cave, and removed material, between the time of its discovery and the excavations of the Bristol Speleological Research Society in 1912-1914. But, aside from Skinner's accounts, we have little record of these activities. The famous antiquarian William Buckland reportedly removed many skeletons (Davies, 1921, p. 62), noting that many of the bones were encrusted with stalagmite (Buckland, 1823, p. 164). William Beard, a farmer turned bone collector, investigated the lower part of the main chamber (A) in the 1820s-40s, and is reported to have found a large number of bones, concerning which no



**Figure 5.** Sketch of human cranium encased in stalagmite and other remains from Burrington Cave (Aveline's Hole) by Rev. John Skinner (Skinner 1824, p. 126).

By permission of the British Library.

information is available (Dawkins, 1864, p. 168). (Beard, best known for his excavations at the Banwell Bone Cave, which yielded a rich Pleistocene fauna, was sponsored by the Bishop of Bath and Wells, understandable in the context of the period, as the remit was to find evidence of the Biblical Flood, and caves full of the bones of extinct animals seemed promising.) Reverend D. Williams of Bleadon dug in the 1820s and in 1829 reportedly found a quantity of flint knives and, inexplicably, what he described as *tesserae* and thought were probably used as gaming pieces (Davies, 1921, p. 62; Rutter, 1829). In 1864, the well-known cave excavator William Boyd Dawkins dug a shaft some 38 feet deep at the back of Chamber B (also known as the Inner Chamber), but found only a part of a sheep skull and a pig tooth (Dawkins, 1864). At this time Dawkins reported that the earlier Buckland collection of skeletons from the cave had already vanished; a single cranium may be all that survives ('calvarium O' equates to A.H. 1; NHM catalogue E11.6.257) (Buckland, 1823, p. 164; Buxton, 1925; Newell *et al.*, 1979, p. 93). A small amount of human material, including a mandible, two mandibular molars and a vertebra (EM504-507), came to the Natural History Museum, London in 1873 via 'Benj. Bright, Esquire', though it is not known when or under what circumstances the material was collected; Jacobi (1982, p. 13; see also Oakley *et al.*, 1971, p. 17) attributes it to the material recovered during the period between the cave's discovery in 1797 and 1840. A single hand phalanx in the Natural History Museum came via N.C. Cooper, who worked on the University of Bristol Spelaeological Society excavations. A small amount of human remains in the Wells Museum is also attributed to Cooper.

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Excavations by the Bristol Speleological Research Society commenced in 1912, but their most important season was 1914 (Williams, 1999, p. 218). No report was published immediately because of the onset of World War I, but it is known that fragments of at least 11 human skulls were found (Davies, 1921, p. 63; Fawcett, 1920; Keith, 1924), reportedly in association with abundant bones of 'giant red deer' (Davies, 1921, p. 68). The better-known excavations by the renamed University of Bristol Speleological Society (UBSS) took place between 1919 and 1931 (Buxton, 1925; Davies, 1921, 1922, 1923, 1925; Fawcett, 1922, 1925; Tratman, 1922, 1923, 1975a, 1977), and it is the material from these excavations that forms the great majority of the surviving assemblage. During this time the main or Outer Chamber was essentially completely excavated, down to the rocky floor that can be seen today. A photograph of the excavations in progress shows a trench extending from near the mouth of the cave well into the interior, against the more prolific north side (Davies, 1923, frontispiece) (Figure 6). In total, some 150 tons of deposit were removed up to the 1925 season (Davies, 1921, 1922, 1923, 1925). Minimal details are available from UBSS log books for subsequent seasons from 1926 to 1930 (UBSS General Log IV), but it is clear that significant additional amounts of deposit were removed from the cave, in the order of approximately 30 tons. In 1928-29, excavations were extended to a trench just outside of the cave entrance.

The available information at first suggests a relatively simple stratigraphy. The floor was covered by a humic layer varying from half an inch to one foot (0.30 m) in thickness, formed of recently washed in material (Davies, 1921, p. 64). Stalagmite bosses still survived at this time along the north side of the cave, though these were discontinuous, undoubtedly in part attributable to disturbance caused by the earlier investigations (e.g., Skinner, 1924). Underneath the stalagmite was a layer of red cave earth at least three feet thick, removed in three, one foot (0.30 m) spits (Davies, 1921, p. 64). It is reported that this layer was never found to have been disturbed beyond the first foot, except at the bottom of a steep incline, though no significant differences between the spits could be identified in the composition of either fauna or lithic material. Faunal and human remains were found in the stalagmite and in the underlying red earth; some of the crania were more or less completely encased (Buxton, 1925; Skinner, 1924, p. 128), and a number of surviving cranial and postcranial still preserve traces of stalagmite. Below the red cave earth was an archaeologically sterile yellow clay-rich sediment. That this stratigraphy is a gross oversimplification is evident from the fact that excavations extended to a depth of between seven and ten feet in many areas, due to voids between rockfall infilling with sediments containing archaeological deposits (Davies, 1925, p. 109-110; see also Donovan, this volume). This also serves to emphasise that the current appearance of the cave has been considerably altered (Figure 6).

Faunal and human bone were reasonably abundant (though the fauna is not quantified beyond relative abundance in the first season, Davies, 1921, pp. 64-65), while lithics were relatively sparse (with perhaps some 250 pieces in total) given the volume of material excavated and certainly do not suggest significant use of the cave for occupation (Jacobi, this volume). Although the excavations were carried out some time ago, Davies was very aware of the small size of the lithic material he was dealing with, and records sorting the material both inside and again outside the cave (Davies, 1921, p. 62); the recovery of small chips suggests that relatively little was missed (Jacobi, this volume). Nevertheless, there is some evidence for occupation, if only for brief episodes. Many of the faunal limb-bones are noted as having been spilt lengthwise for marrow extraction, including those of horse as well as the large deer that are noted as being by far the most abundant large mammal (Davies, 1921, 1922, 1923, 1925).

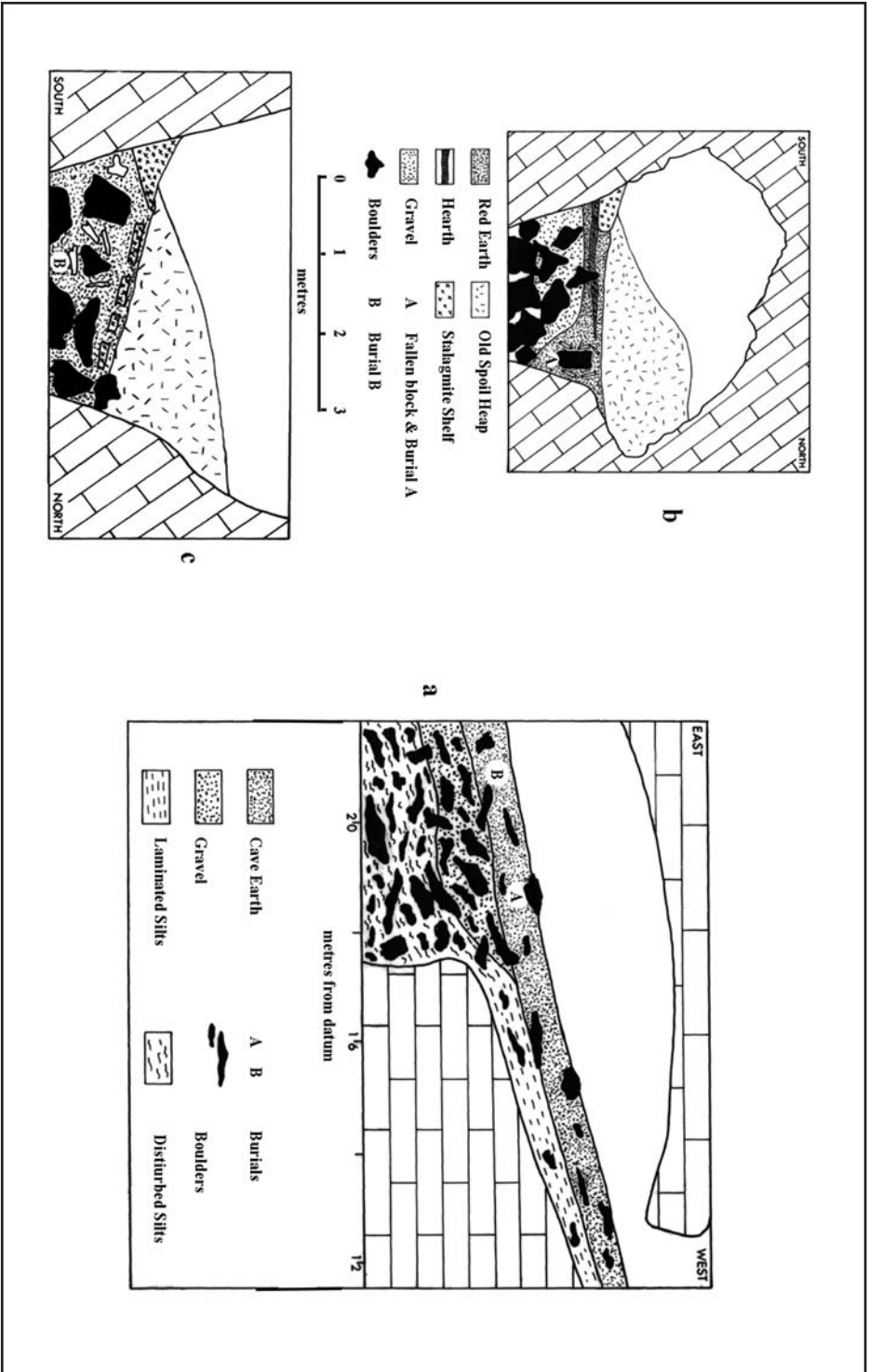


**Figure 6.** *Trench along the north side of Aveline's Hole under excavation by the University of Bristol Spelaeological Society c. 1922.*

In addition, Davies (1925, pp. 105, 113) notes the presence of a number of thin hearths throughout the cave.

It seems likely that the UBSS excavations were largely dealing with the partial and scattered remains from previous excavations, particularly as they are noted being as concentrated against the left (north) hand side of the cave, which is where the original skeletons also seem to have been found (Skinner, 1824, p. 128). This was the drier side of the cave, and received the most light (Davies, 1923, p. 14). (However, it hardly seems that light could have been of much concern to the users of the cave, as the majority of the remains, human, faunal, and presumably lithic, were found between 20 and 30 m back from the entrance, where relatively little light penetrates. This coincides with the only area of the outer chamber where the floor today is relatively level.) The level of previous disturbance of the deposits could also account for the presence of numerous scattered perforated periwinkle shells (*Littorina obtusata*) (Davies, 1921, pp. 68-69, Fig. 10.2); while their association with the burials cannot be considered completely secure, it does seem highly likely that these are grave goods or personal ornaments interred with the dead. Perforated periwinkle shells are found in abundance with the burials of the Late Mesolithic cemeteries of Tévéc and Höedic in Brittany (Péquart and Péquart, 1954; Péquart *et al.*, 1937). Though of less certain association with burials, periwinkle and cowrie (*Trivia* sp.) shell beads have also been found at Mesolithic rockshelter and cave sites in the Wye Valley (Barton, 1994, 1996) and Devon (Barton and Roberts, 2004), and at the Mesolithic shell midden at Culverwell, Dorset (Palmer, 1999).

An exception to the generally scattered remains is provided by the so-called double 'ceremonial burial' ('Burial A') found in the 1924 season. The burial was found upon the removal of an old spoil heap, some 60-65 ft from datum (datum being near the mouth of the cave) and reaching from the north wall to some 5 ft out, and may have been associated with a hearth found just above it (Davies, 1925, pp. 106, 110), either through being placed into a disused hearth, or having a ritual hearth made over the burial. No mention is made of the human bone being affected by fire, though 18 deer incisors in possible association with the burial all show scorching (Davies, 1925, pp. 106-109). Fragmentary human and animal bones were found from the surface down to a depth of 5 ft; this is thought to be the result of a large block of limestone falling from the roof and crushing the underlying burial and forcing some elements down into voids between underlying blocks of stone (Davies, 1925, p. 106). The bones appear to be those of two adults, one larger and more robust (*ibid.*). There is a slight indication of red staining that could be red ochre, though the red cave earth ubiquitous to the cave sediments of south-west Britain (see Macphail below) could be the cause of this, though such staining is not noted for other material, nor can it be observed on the surviving collection. (It is worth noting that excavations in 1927 in this general area of the cave record three additional flints, human and animal bone, a broken shell bead and a piece of ochre (UBSS General Log IV, 26-27.3.27). Apparently in association were perforated and notched animal teeth, including a damaged horse tooth the root of which had been engraved with parallel lines, similar to those found on horse teeth at Kendrick's Cave in North Wales, where a decorated horse mandible has been directly dated to 10100 ± 200 BP (OxA-111) (Gillespie *et al.*, 1985; Sieveking, 1971). Two of the perforated teeth are identified as the upper canines of a female pig (Davies, 1925, p. 107), though it is clear from an accompanying photograph (*ibid.*, Plate VII.6) that they are in fact red deer canines (Murray and Schulting, below).



**Figure 7.** Long- and cross-sections of the Aveline's Hole at locations of burials 'A' and 'B'. Redrawn from Davies (1925).  
UBSS archive

Two groups of six regular incisions were found on another bone fragment (said to be a fragment of deer tibia) in possible association with the burial (Davies, 1925, Plate 7.5). This perhaps could be compared to a bird bone awl with multiple groups of from four to six short, parallel incised lines found at Gough's Cave (Jacobi, 1982, Fig. 2.1). Newton (1925) identified the metacarpal of a Great Bustard (*Otis tarda*) amongst the bones in possible association with the burial. A drilled metapodial, possibly of bear, was subsequently noted in the assemblage by Tratman (1975b, cited in Mullan and Wilson, 2004, pp. 80-81), and may also belong with this burial, or with another. Fourteen flint blades were also found in association with the bones of this group. Perhaps the most intriguing find is a 'nest' of seven fossil ammonite body cases found near cranial fragments and so possibly placed near the head (Davies, 1925, p. 108, Plate 7.1). The fossil shells show no signs of working, but Donovan (1968) suggests that they were intentionally selected for their consistent shape and smooth edges; the nearest source for these shells is some 16 km from the site. Finally, a small rectangular sandstone slab, otherwise very rarely encountered in the cave, may have marked the location of the burial (Davies, 1925, p. 108). Given its stratigraphic position, there is some suggestion that this burial may be earlier than the others in the cave (e.g., Mullan and Wilson, 2004), possibly even belonging to the Late Upper Palaeolithic Creswellian (c. 12900-12000 BP). The evidence for this is, however, rather tenuous. Efforts to identify and date human skeletal remains that can be attributed to this burial are continuing.

What has received less attention is a second group of human bones (presumably 'Burial B' in the UBSS catalogue, though this is not certain) found against the south wall some 70 ft from datum, in fact nearly adjacent to 'Burial A' discussed above (Davies, 1925, Fig. 4, assuming that the designation 'A' used in Fig. 3 for the ceremonial burial is the same as used in Fig. 4, though this is not made explicit in the text) (Figure 7). Stratigraphically the finds lay in the red cave earth below a thin stalagmite floor. Again extensive rock falls in the area are thought to be responsible for the fragmented and disturbed state of the bones (Davies, 1925, p. 112). The human remains are reported as comprising one adult. While Davies did not believe this to be a 'ceremonial burial', he proceeds to list the various items seemingly found in association. These include six flint blades (and recall how infrequently lithics are found elsewhere in the cave), numerous red deer teeth (though none are said to be perforated) and the tooth of a young brown bear. Finally, against the south wall '...and so close to the bones as to be regarded in association with them, lay the beams of three giant deer antlers with the frontal bones attached, and several broken tines and incisors of the same beast' (Davies, 1925, p. 112). The use of bear and horse teeth as ornaments is found at Kendrick's Cave in North Wales, also dating to the Late Glacial and early Holocene (Eskrigge, 1880; Sieveking, 1971), and the placement of red deer antlers with burials is a well known practice from the Mesolithic of southern Scandinavia and Brittany, though these are more often, but not invariably, shed than unshed (Schulting, 1996). In total, then, this is at least suggestive of another intentional burial with grave offerings. Nor would this be surprising in an Early Mesolithic context.

As noted above, relatively little information is available for the 1926-1930 seasons. The most noteworthy event is perhaps the discovery in 1926 of a new chamber on the north side of the cave (Figure 2), with two entrance passages at 60-62 ft (c. 18.3 m) and 66-69 ft (c. 20.5 m) distance from datum. The first of the passages is noted as being below Burial 1. The passages and chamber are recorded as yielding 'very numerous human bones' as well as two flints, a deer canine, and a portion of a wild cat mandible (UBSS General Log IV, 24.5.26). A summary of the finds mentioned during the period 1926-30 includes abundant human bones and teeth, longitudinally split long bones, deer and reindeer bones, antler and teeth, a wild cat canine, a pig humerus, horse phalanges, bird bones and numerous rodent bones. A number of

lithic finds are noted, as are a drilled metacarpal (tentatively identified as deer) and a broken shell bead.

Little work of note was undertaken at the cave for the next 70 years. However that the site can still yield some surprises was demonstrated in 2003 when a series of incised lines was discovered on the cave wall (Mullan and Wilson, 2004, Figs. 2-4). The abstract geometric design (two rows of 'X' engravings) is consistent with motifs seen in Late Upper Palaeolithic cave art known elsewhere in Europe, but parallels can also be found on portable art dating to the Early Mesolithic, and it is this later date that Mullan and Wilson prefer, raising the intriguing possibility of some association between the carvings and the mortuary use of the cave.

## THE SURVIVING HUMAN BONE COLLECTION

(R. Schulting and M. Wysocki)

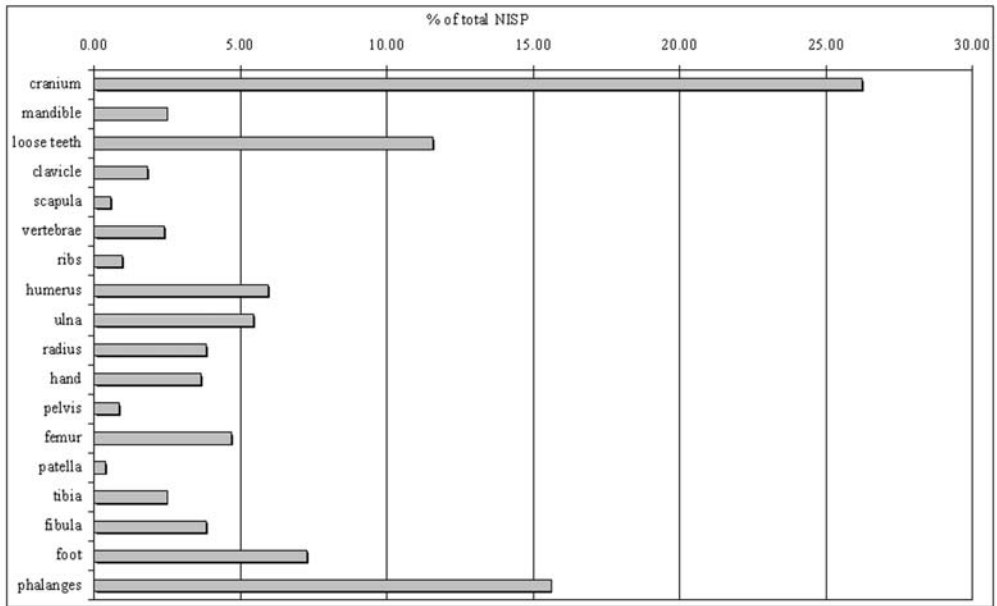
The Aveline's Hole collection was greatly damaged by an air-raid on Bristol in 1940. Much material was subsequently recovered, though often in a very partial and fragmentary state, and it is this that forms the focus of this study. Unfortunately much of the associated documentation was also lost. Given its turbulent history, the attribution of all of the elements in the surviving collection to Aveline's Hole must be treated with an element of caution, though it can be supported to some degree by the dating programme (see Marshall and van der Plicht, below). Human remains attributed to the site are currently held in the Wells Museum, the UBSS Museum, and the Natural History Museum, London.

We originally reported the presence of some 800 elements in the collection (Schulting and Wysocki, 2002). This can now be increased slightly to some 860 elements largely through the identification of previously uncatalogued and unidentified specimens. This is obviously still a very pale reflection of what was originally present, firstly in the UBSS Museum before the war, but even more so when compared with the collection at the time of its original discovery in the late eighteenth century.

The human remains from Aveline's Hole are given the designation M1 in the UBSS catalogue, followed by .11 for cranial elements and teeth, .12 for the appendicular skeleton (the vertebral column and ribs), .13 for the upper axial skeleton (upper limbs) and .14 for the lower axial skeleton (the lower limbs), and, finally, followed by unique catalogue number (e.g., M1.11.145). M2 refers to faunal remains, of which few survive (see Murray and Schulting, below). The present re-examination has resulted in a number of changes in the identification of elements, in some cases from, for example, upper to lower limb. More drastically, a small number of elements catalogued as human have been re-identified as faunal. We have not renumbered such elements, but simply noted the new identification in the revised human and faunal catalogues (copies of which have been placed on file at the Wells Museum and the UBSS). In all cases, newly numbered elements begin at 300 within each region of the skeleton (e.g., M1.11.300 for cranial elements), to distinguish them from the post-war UBSS catalogue numbers. The proportional representation of the different elements of the skeleton, including both extant and catalogued specimens, is shown in Figure 8.

A relatively small number of specimens (approx. 30) listed in the UBSS catalogue as surviving the Blitz have still not been located: a proportion of these may be accounted for by specimens that had to be renumbered as their original numbers could no longer be read. Conversely, a number of specimens catalogued as having been lost in the Blitz are in fact still present in the collection (e.g., M1.11.16-22, 25, 31, 33, 35). That material was actually rescued

from the aftermath of the fire is seen in a number of specimens of the same skeletal element which have been burnt to a uniform gray colour, indicating that they must have been stored together as a group (e.g., many of the clavicles, including M1.13.96, 101, 177-184; also a group of 14 proximal phalanges together designated as M1.13.339). A combined total of 194 elements listed in the catalogue are currently absent from the collection: of these, 162 are recorded as having been destroyed in the Blitz. Unfortunately, these include a series of mandible fragments, many recorded in the catalogue as having teeth still *in situ*.



**Figure 8.** Proportional representation of skeletal elements at Aveline's Hole incorporating both extant and catalogued specimens. 'Hand' and 'foot' refer to carpals/metacarpals and tarsals/metatarsals, respectively.

Context information is preserved directly on a number of elements and/or in the reconstructed post-war UBSS catalogue, transcribed from such fragmentary records as survived, or from the recollections of excavators (e.g., Tratman) (summarised in Table 1), but with the loss of the site archive and the excavation records it is not possible to place many of these horizontally or vertically. It is clear that some conjoining elements derived from different contexts (e.g., two joining fragments of a right fibula, M1.14.132 and 109, are reported as coming from CXXXVII and CXIII(II), respectively), though it is not known whether these are contiguous horizontally or vertically. Given the levels of disturbance at the site, due both to previous investigations and to rock falls, it is not clear how useful this would be in any case. Of the 26 contexts designated with a Roman numeral, ten appear to have only human remains subscribed to them, eight have only faunal remains, while the remaining eight have both (based on a total of 169 human and 23 faunal elements). This could suggest some degree of separation in the contexts for human and faunal remains, a scenario receiving some support from the presence of 'giant deer' antler, split deer and horse long bones, and other large mammal and rodent remains noted at 48 ft from datum and again at 50-60 ft from datum (Davies, 1925, pp. 105-106), whereas practically no human remains were recorded before 60 ft from datum (see below).

'Pit'	
1st foot	
5 ft from datum loose on floor, 1968	
60-65 ft from datum	
60-70 ft from datum	
LHS 65-70 ft from datum; 4 ft from side	
63 ft from datum under Burial I	
LHS 63 ft from datum under Burial I	
RHS 64 ft from datum, under Burial I	
64 ft from datum 4 ft from LHS	
65 ft from datum 4 ft from LHS (= CIII)	
LHS 64 ft from datum	
bottom of slide 60 ft from datum	
below slide 62-64 ft from datum (= CXVII)	
65-70 ft from datum 4 ft from LHS	
66-70 ft from datum	
70 ft from datum	
70-75 ft from datum	
70-75 ft from datum 4.5 ft below stalagmite shelf (= CXIII)	
75-80 ft from datum, along N wall	
88-94 ft from datum 88-94 ft from datum, 1st foot	
Burial II	
exterior 1 ft below undisturbed material	
exterior of cave	
foot of 64 ft chute	
in new portion of cave to L of bottom of pit as this was deepened by excavation	
CIII, 65 ft from datum 4 ft from LHS	human only?
CVI	human only?
CVII (I)	faunal only?
CVIII (I)	human and faunal
CXII (I)	faunal only?
CXIII, 70-75 ft from datum 4.5 ft below stalagmite shelf	human only?
CXIII (I), 70-75 ft from datum 4.5 ft below stalagmite shelf	faunal only?
CXIII (II), 70-75 ft from datum 4.5 ft below stalagmite shelf	human and faunal
CXVI	faunal only?
CXVI (I)	human and faunal
CXVI (II)	human only?
CXVI (III)	human only?
CXVII, below slide 60-62 ft from datum	human and faunal
CXVII (B), below slide 60-62 ft from datum	human and faunal
CXIX	faunal only?
CXX	faunal only?
CXXI	faunal only?
CXXIX	human only?
CXXVII (II)	human only?
CXXVIII (II)	human only?
CXXX indicates cave interior past roof niche	human only?
CXXXIII	human and faunal
CXXXVII	human and faunal
CXXXVIII	faunal only?
CXXXIX	human and faunal
CXL	human only?

**Table 1.** List of contexts found written directly on human bone or in UBSS catalogue, with some corresponding locations in the cave as recorded in the UBSS catalogue.



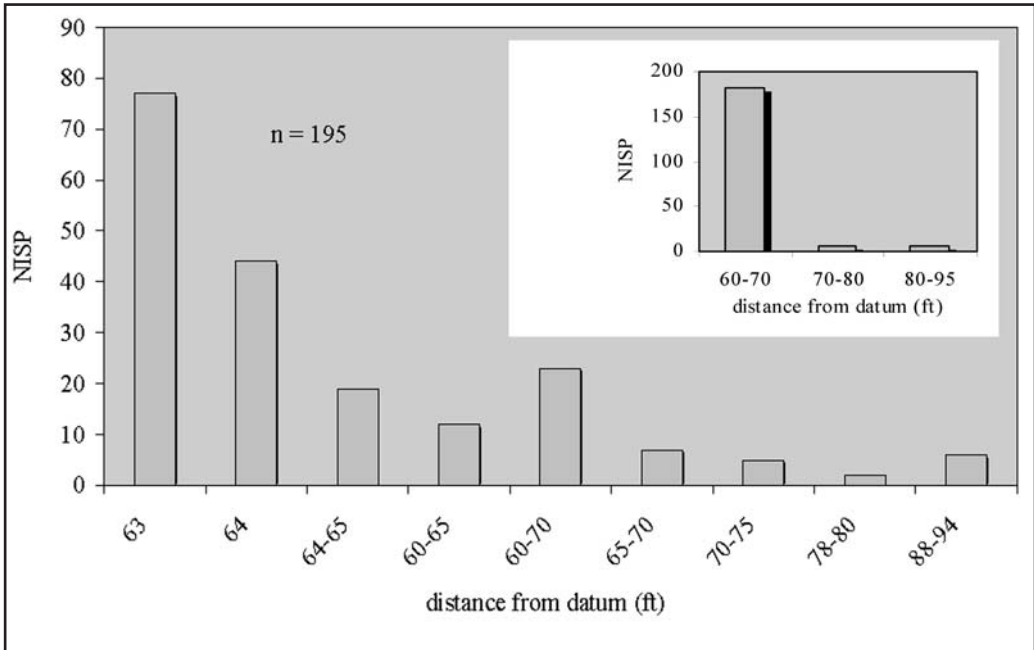
Roman numerals sometimes given as suffixes in brackets are restricted to I, II, and III, which could suggest that they refer to the three, one-foot spits used to excavate the red cave earth (Davies, 1921, p. 64), but the designations survive only infrequently and so are of limited use. (Information attributing the small faunal collection in the Natural History Museum, London, to either the first or third spit is preserved far more consistently; see Murray and Schulting, below).

In other cases the UBSS catalogue records distances from datum (referring to the cave entrance, although its precise location is unknown), for example '60-65 ft', without specifying a context number (though sometimes these can be matched up). The most useful information gained here is the location of the human remains as a group in the cave. The great majority of those for which any information exists are recorded as being found between 60 and 94 feet (18.3-28.7 m) from datum (Figure 9). This is the point where the steep entrance slope levels out, while just past 30 m there is a second and steeper descent, though this seems to be in part the result of Boyd Dawkins' 1864 shaft (see above). However, the apparent strong concentration of human bone between 60 and 70 ft may be in part an artefact of previous diggings in the cave, since a large 'old spoil heap' was also found in this area (e.g., Davies, 1923; 1925, p. 105, Fig. 2), and a good portion of the human bone derives from it (Davies, 1923, p. 5). Moreover, a deep rocky fissure was found beginning at 60 ft from datum (Davies, 1925, pp. 109-110, Fig. 4) (Figure 6). Excavation here proceeded to over 10 ft below the original floor level without reaching bottom. The nature of the fill, containing many fallen limestone blocks and unstable air cavities, was such that many bones had fallen down from higher up.

A few human and faunal elements were reported as being found in the 'vestibule' area of the cave (Davies, 1925, pp.104-105), but these cannot be identified in the extant collection. Only a single human tooth (M1.11.247) has subsequently been found in this area, recovered on the surface some 5 ft. into the cave in 1968. With this exception, there are no human remains recorded in the UBSS catalogue between the entrance and 60 ft. from datum (18.3 m). The only other location mentioned refers to a group of mainly cranial fragments (M1.11.181-190) together with a tarsal (M1.14.74) from the exterior of the cave, possibly from the 1928-29 excavations of a trench there (UBSS General Log IV). These presumably relate to the spoil from earlier diggings in the cave, though another element, a lumbar vertebra (M1.12.15) is recorded in the UBSS catalogue as deriving from 1 ft. below undisturbed material. Still, it seems most probable that these represent isolated fragments from earlier excavations, perhaps including those going back to the early nineteenth century. A degree of horizontal separation, then, may be seen between the fauna and lithics, some of which are also recorded as coming from nearer the cave entrance (e.g., Davies, 1923, pp. 9-10), and the human remains. Against this, however, is Skinner's (1819, pp. 106-107) statement that 'a number of skeletons were seen lying on the left hand side of the Cave about *twenty feet from the entrance*' (emphasis added).

Some of the elements in the extant collection can be identified as belonging to the same individual. One of the best examples of this involves four metacarpals of the right hand (M1.13/347, 368, 369, 370); not only are these well matched in size, but, more tellingly, metacarpal III and IV lack each lack a corresponding facet that is normally present (Figure 10). Four metacarpals of the left hand match one another for size (M1.13/346, 362, 363, 366), and also match the bones of the right hand. It is likely that some of the carpals can also be attributed to this individual, though not as strong a case can be made. Only one of the group of metacarpals, M1.11.366, has a provenance: CXXX, referring to the area past the 'roof niche' (Figure 2), though this is hardly a useful designation, as nearly all of the human remains are recorded as coming from beyond this feature. However, it might suggest the continued presence of articulated, or nearly so, remains in the cave in the early twentieth century. The presence of many of

the small bones of the hands and feet also further confirms the presence of entire, articulated skeletons in the cave rather than secondary burials (cf. Skinner, 1819; Wansey, 1805), though the latter would not be out of place in an Early Mesolithic European context (Cauwe, 2001), and may of course have also been present.



**Figure 9.** Distance from datum (cave entrance) specified for 195 human skeletal elements as recorded in the UBSS catalogue. The vast majority of the surviving elements are recorded as coming from 60-70 ft from datum (inset), though this is likely to be in part an artefact of previous digging.

The UBSS catalogue lists a large number of fragments as belonging to, or lying underneath, ‘Burial I’, though from the available published reports it is not clear exactly to what this refers. It is possible that it refers to either ‘Burial A’ or ‘B’, as discussed above, with ‘A’ being the more obvious choice, but such provenance details as are available place Burial I on the right (south) hand side of the cave, 64 ft from datum. This matches the description for ‘Burial B’ in terms of being on the south side of the cave, where remains were comparatively rare (Davies, 1925, p. 112, Fig. 4). On the other hand, the distance from datum matches better that for Burial A. In either case, this group of remains appears to date to the 1926 season, when a new chamber was discovered against the north side of the cave at this distance. One of the two entrance passages to this side chamber is noted in the UBSS General Log IV (24.5.26) as lying ‘below burial I’. This would explain why this group of remains is not referred to specifically in the published reports, and the confusion over what Burial I/I refers to.



**Figure 10.** a) Four metacarpals of the right hand (M1.13/347, 368, 369, 370) belonging to the same individual; not only are these well matched in size, but b) metacarpal III and IV each lack a corresponding facet that is normally present (comparative normal examples on left, Aveline's Hole on right).

### *The dentition*

The dentition consists for the most part of isolated teeth, many of which are damaged through post-depositional breakage of the roots and chipping and loss of the enamel. The poor condition of the dentition makes firm identification very difficult in many cases, particularly in terms of differentiating, for example, first and second lower molars, and siding the teeth. The problem is exacerbated by the apparently high frequency of ‘unusual’ conditions in this population, such as often poor separation of the buccal and lingual roots of the maxillary molars. Thus many of the identifications presumably made by Tratman (a dentist) in the original catalogue have been changed, in some instances with certainty (e.g., some teeth identified as third molars show both mesial and distal wear facets, which is not possible in a third molar), but in other cases more tentatively. The broad categories of teeth, however, are reasonably secure.

Taking into account both present and catalogued teeth (Table 2), the dentition provides a minimum number (MNI) of eight or nine older adolescents or adults (based on maxillary left second and right third molars, and mandibular right first molars) and at least two subadults, including a young child aged 2-3 years (an unworn deciduous second molar and slightly worn deciduous incisor) and an older child aged 4-7 years (a slightly worn deciduous canine) (Ubelaker, 1978). An impacted third mandibular molar with incomplete root formation indicates the presence of a young adolescent aged *c.* 12-16 years (M1.11.174) (Figure 11).

### *Bone modification*

As noted in the preliminary report (Schulting and Wysocki, 2002), a number of elements in the surviving assemblage show considerable physical and/or geochemical erosion. The extent of erosional processes could be in part responsible for the low representation of immature individuals (cf. Karkanas *et al.*, 2000), though, as noted below, those subadult elements that are present seem reasonably well preserved. These modifications strongly suggest that the burials were either exposed directly on the cave floor or lay relatively close to the surface (cf. Karkanas *et al.*, 2000; Stiner *et al.*, 2001). This is also indicated by the presence of rodent gnawing on at least 14 surviving elements. This represents less than two percent of the total collection, but then as noted above the bone surfaces of a significant proportion of elements are not well preserved. Gnawing by two sizes of teeth can be seen on one radius (M1.13.308), and a few elements show carnivore rather than rodent gnawing (e.g., humeri M1.13.94, 328, metatarsal M1.14.27). The absence of more significant carnivore damage could support the idea of the cave being sealed, whether intentionally or not, not long after its use for burial. It also suggests that even during the period of its use for burial, some care was taken to ensure minimal disturbance by carnivores. Gnawing is also noted on a number of human elements lost in the Blitz; and both carnivore (possibly including the human variety) and rodent gnawing is present on a small proportion of the surviving faunal collection (see Murray and Schulting, below).

Despite claims in the UBSS catalogue, no intentional bone modification in the form of cutmarks or ‘tectiform designs’ can be observed in the surviving human bone assemblage. A small number of specimens with claimed modification are missing, but in light of an examination of those that are present, it is unlikely that any cutmarks would be supported (unlike the situation with the Creswellian human remains from Gough’s Cave, where numerous definite stone-tool cutmarks have been identified and the possibility of cannibalism raised; Andrews and Fernández-Jalvo, 2003; Cook, 1986, 1991; Currant *et al.*, 1989). The deer tibia with two groups of incisions from the ‘ceremonial burial’ noted above is shown in Davies (1924, Plate 7.5). Unfortunately, the specimen cannot be located, but a recently rediscovered photograph of

Tooth	Present in surviving collection					Total	Noted in UBSS catalogue				Total	Grand Total
	L	L?	R	R?	side?		L	L?	R	side?		
canine					1	1						1
mand. C	1	2	2			5			1	1	2	7
mand. C/I					1	1						1
mand. C/I?					1	1						1
mand. C?	1					1						1
mand. crown										1	1	1
mand. I	2					2	1			1	2	4
mand. M fragment					1	1						1
mand. M1	7		6			13	1	1			2	15
mand. M1/2?					1	1						1
mand. M2	4		4	1		9	4		1		5	14
mand. M3	2		1			3	1		2		3	6
mand. PM		2			1	3			1	1	2	5
mand. PM?					1	1						1
mand. PM1	1		3			4			1		1	5
mand. PM1?			1			1						1
mand. PM2	1		2			3						3
mand. PM2?		1		1		2						2
mand. tooth							1				1	1
mand. ? PM2								1			1	1
max C			3			3				1	1	4
max C1			1		1	2	1			1	2	4
max I		1				1						1
max I?					1	1						1
max M					1	1						1
max M1	5		6		1	12	1		1		2	14
max M2	6		5			11	3				3	14
max M3	1		7			8	1		1	1	3	11
max PM1		1	2	1	1	5			1	1	2	7
max PM1 root			1			1						1
max PM2	3		2			5				1	1	6
PM/M fragment					1	1						1
M fragment					3	3						3
mand I1			2			2						2
mand I1?	1					1						1
mand I2	1		1			2						2
mand I2?			1			1						1
max i2?	1					1						1
max i1?			1			1						1
max PM2?	1					1						1
<b>Grand Total</b>	<b>38</b>	<b>7</b>	<b>52</b>	<b>3</b>	<b>15</b>	<b>115</b>	<b>14</b>	<b>1</b>	<b>10</b>	<b>9</b>	<b>34</b>	<b>149</b>

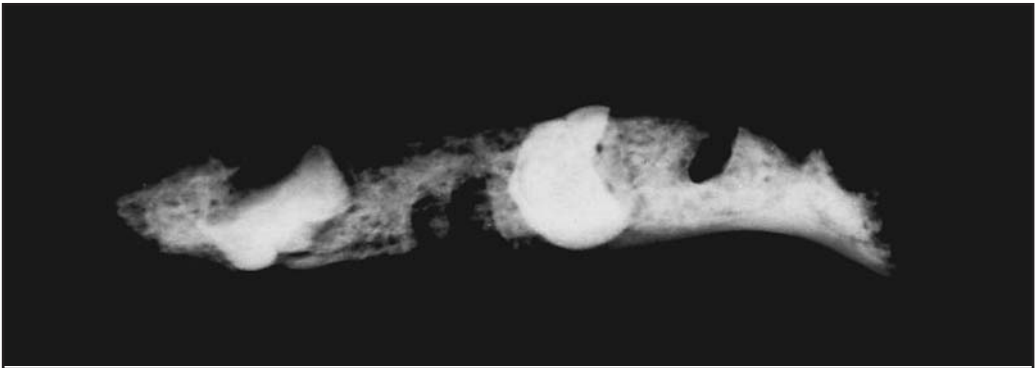
**Table 2.** Summary of teeth present in the surviving collection and in the UBSS catalogue.

<i>Tooth</i>	<b>Present in surviving collection</b>					<b>Total</b>	<b>Noted in UBSS catalogue</b>				<b>Total</b>	<b>Grand Total</b>
	<i>L</i>	<i>L?</i>	<i>R</i>	<i>R?</i>	<i>side?</i>		<i>L</i>	<i>L?</i>	<i>R</i>	<i>side?</i>		
molars	25	0	30	1	6	62	11	0	6	1	18	80
premolars	6	4	11	2	3	26	0	1	3	3	7	33
posterior teeth	31	4	41	3	10	89	11	1	9	4	25	114
incisors	5	1	6	0	2	14	2	0	0	2	4	18
canines	2	2	5	0	1	10	0	0	1	2	3	13
anterior teeth	7	3	11	0	5	26	2	0	1	4	7	33
<b>Grand total (excluding an unidentified root and a crown fragment)</b>												<b>147</b>

NB: includes one deciduous incisor and one deciduous molar

Table 2b. *Summary of teeth present and in UBSS catalogue.*

it further confirms that these cuts appear to form a simple design or tally rather than being butchery marks (Mullan and Wilson, 2004, Fig. 6). No elements show fracture patterns indicative of fresh bone breaks.



**Figure 11.** *Radiograph of mandible fragment (M1.11.174) with impacted third mandibular molar belonging to an adolescent c. 12-16 years of age.*

## DEMOGRAPHY

(R. Schulting and M. Wysocki)

### *Minimum Number of Individuals*

At least 15, but more probably 16, adult or adolescent proximal left ulnae are present (Schulting and Wysocki, 2002, Fig. 2). This is the single most common element, and presents a basic MNI for the surviving material, one reasonably close to the total of 20 individuals indicated for the UBSS excavations. However, this estimate may have been too low; according to Tratman (1975b), in around '1923 a count was made of the petrous portions of the temporal bone that had been found. The minimum number of persons was then 25. More similar bones were found later, therefore the original account of 50 or more can be accepted as reasonably accurate. There may well have been more'. The current MNI is increased by the presence of a small number of subadult specimens, representing five individuals and bringing the total

number of individuals identified at Aveline's Hole to 21, as was noted in the preliminary report. No additional individuals have been identified.

Considering what the collection has been through, this is not an unreasonable number in relation to the reported presence of 50 or more individuals in the early accounts. Newell *et al.* (1979, pp. 91-93) report between 50 and 100 individuals at Aveline's Hole, and Smith (1992a) reports 70 or more individuals; similar figures were used in the preliminary report (Schulting and Wysocki, 2002), but after further research the source of these higher estimates is not clear. Thus the figure of '50 or more' individuals is probably the best available estimate.

### Age

The five subadults represented include three young children (ages 2.5-4.5, 3.5-6.5, and 5-7 years), an infant of 6-18 months, and an infant at or near term (*i.e.*, neonatal or perinatal). Each of these age ranges is represented by only a few elements (Table 3). In addition, at least two adolescents are represented by unfused basioccipital elements, indicating an age of 13-17 if female, and 15-19 if male (Scheuer and Black, 2000, Fig. 11.7). These do not add to the overall

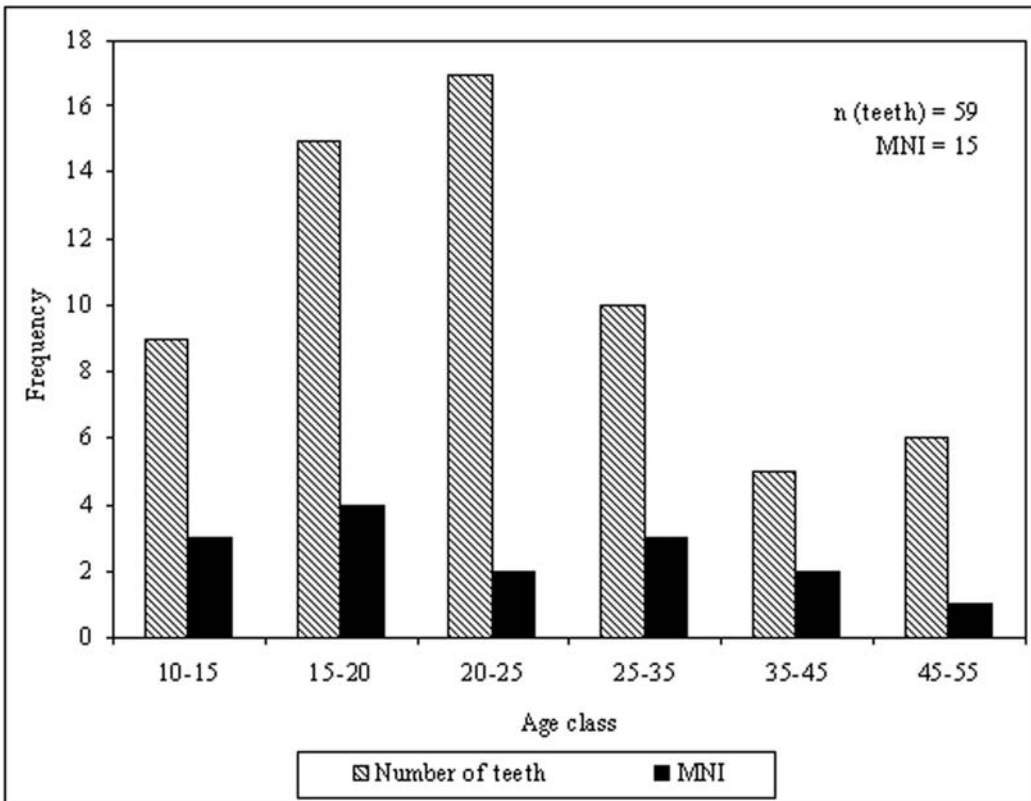
<i>Catalogue no.</i>	<i>Element</i>	<i>Age</i>	<i>Comment</i>
M1.11/104	incisor?		deciduous?
M1.11/178	incisor		deciduous; edge slightly worn
M1.11/242	max. canine, L	ca. 4-7	deciduous; cusp worn
M1.11/307	cranial fragments	= 2 yrs	metopic suture closing
M1.11/334	cranial, basioccipital		fuses 13-17 in F, 15-19 in M
M1.11/335	cranial, basioccipital		fuses 13-17 in F, 15-19 in M
M1.12/18	vertebra, cervical	5-7 yrs	unfused vertebral discs
M1.12/19	vertebra, thoracic	5-7 yrs	unfused vertebral discs
M1.12/312	vertebra, thoracic		unfused vertebral discs
M1.13/58	humerus, shaft	4-8 yrs	based on small size
M1.13/126	radius, shaft fragment	child	based on small size
M1.13/161	ulna, L proximal	< 19 yrs	head eroded but appears unfused
M1.13/304	scapula	immature?	bone appears subadult but cannot be specific
M1.14/104	femur, R distal epiphysis	2.5-4.5 yrs	max. width 44 mm
M1.14/105	femur, R distal epiphysis	3.5-6.5 yrs	max. width 47.8 mm
M1.14/126	femur, head	< 16 yrs	unfused
M1.14/305	femur, R proximal half	perinatal	length c. 8 cm
M1.14/306	calcaneus	6-18 mon	max. length 24.2 mm

**Table 3.** *Subadult elements present in the surviving Aveline's Hole human bone collection.*

total since some of the ulna shaft fragments noted above are quite small and could represent adolescents in this age range. The catalogue and excavation reports do not reliably record the presence of additional subadults, and so their paucity in the surviving collection is unlikely to be due to loss during the Blitz. Davies (1923, p. 8) does note the presence of a number of long bones from 'young' individuals and a child's cranium but no more specific details are provided. It is possible that the explanation instead lies in the dual processes of the destruction of immature bone by geochemical processes and the incomplete retrieval of small elements during the UBSS excavations. That the latter may be a more important factor is indicated by the fact

that the extant subadult elements appear as well preserved as the adult elements, though against this is the presence of small lithics and rodent bones in the collection. The five subadults below eight years of age represent 24% of the total surviving MNI, though a much smaller proportion of the total number of identified human bones.

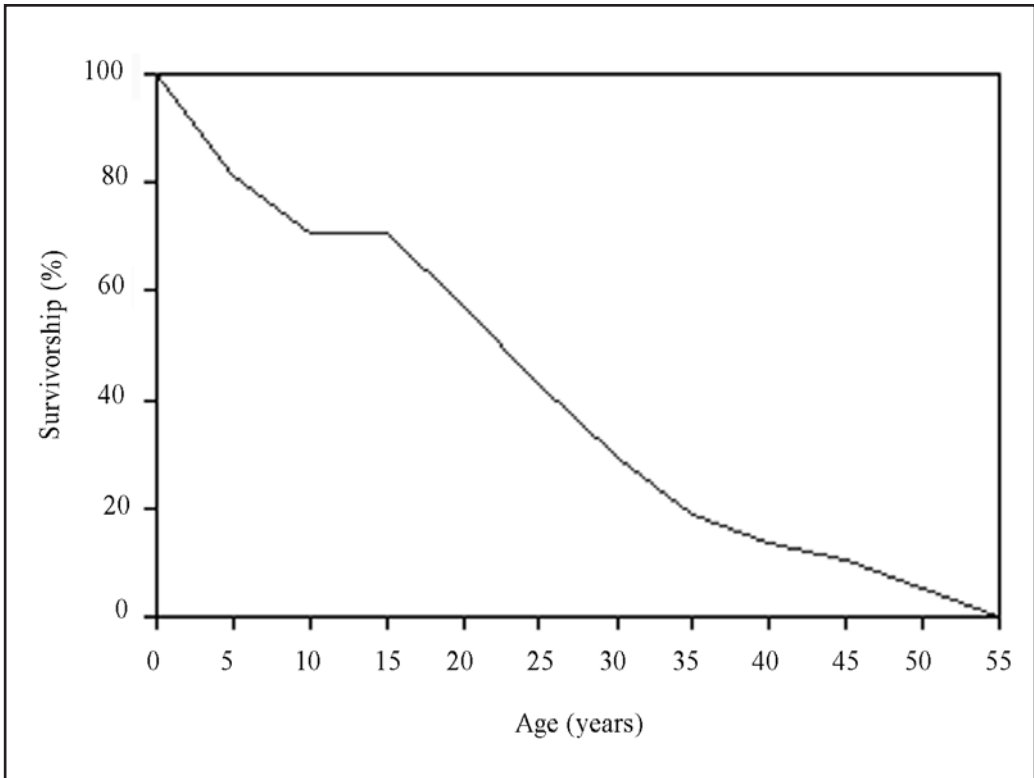
Obtaining an age distribution for the Aveline's Hole adults is more difficult. Given the poor survival and fragmentation of other elements, the dentition serves best for this purpose, but for the most part this is limited to individual teeth rather than complete (or even partial) jaws. In the preliminary account it was suggested that relatively few older individuals were represented (Schulting and Wysocki, 2002, p. 259). A surprising number of teeth are from individuals that would normally be assigned on the basis of their wear stage to adolescent or young adult status (15-25), while possibly only one or two individuals reached greater than 45 years of age at death (Figure 12). While this may indeed be the case, there is some indication from microwear analysis that the diets of the Aveline's Hole population were rather softer than might be expected for hunter-gatherers, which would result in less rapid dental wear (see McLaughlin below). Thus, the impression that mainly younger adults are represented could be open to reinterpretation. In addition, while a large proportion of the teeth may derive from older adolescents or young adults, the minimum number of individuals they represent is less disproportionate relative to the other age groups (Figure 12).



**Figure 12.** Bar graph of permanent molars in age categories according to wear stage (after Brothwell, 1965; Miles, 1963; Smith, 1984).



Combining the age-at-death estimates for the subadults and adults allows the construction of a survivorship graph (Figure 13). A steeper line (*i.e.*, higher mortality) would typically be expected in the 0-5 age category. While subadult mortality is within the lower end of the range indicated for pre-industrial populations (Weiss 1973), it is likely that very young children (0-1 years of age) in particular are underrepresented, and perhaps were generally not buried in the cave. The presence of older children in the Mendips is repeated at Badger Hole, where the partial cranial remains of two children aged approximately five and nine years have been dated to the same period as Aveline's (Burleigh 1986; Oakley *et al.*, 1971, p. 20).



**Figure 13.** *Estimated survivorship curve for the Aveline's Hole burial population.*

#### Sex

As noted in the preliminary report (Schulting and Wysocki, 2002), some previous accounts have suggested that the majority of the burials in Aveline's Hole were of females (Fawcett, 1922; Tratman, 1922), but this is a misconception probably relating to the relatively small physical size of the population. Both morphological and size differences between a number of adult long bone fragments, together with limited (due to the fragmentary and incomplete nature of the collection) application of univariate discriminate functions, are sufficient to clearly indicate the presence of both males and females. In addition, sex can be suggested for a number of cranial fragments preserving the orbital, nuchal or temporal area. For the orbital region, four males (M1.11.1, 182, 204, 210) and five females (M1.11.12, 98B, 214, 219, 245B) may be indicated. Two occipital fragments (M1.11.29, 348) have pronounced external occipital

protuberances indicating they are male (though of course this does not add to the total based on orbits, since the same individuals may be represented). Of the two more complete surviving crania, calvarium O (for ‘Oxford specimen’, where the specimen was originally curated before moving to its current location in the NHM, London) (A.H. 1) is probably male (Buxton, 1925), while A.H. 9 can be tentatively identified as female, though the latter’s attribution to Aveline’s Hole is not entirely secure (Balch, 1947, p. 79; Meiklejohn, *pers. comm.*; Oakley *et al.*, 1971, p. 18). ‘Cranium 4’ (Figure 14) is quite gracile and likely female. This provides for a total of at least five adult males and six or seven adult females.



**Figure 14.** *Left lateral view of reconstructed ‘Cranium 4’ (M1.11.301), an adult female. The orbits exhibit slight pitting known as cribra orbitalia.*

#### OSTEOMETRICS/ODONTOMETRICS (R. Schulting and M. Wysocki)

Few elements are sufficiently complete for the taking of meaningful osteometric data. Of the ten femora that permit the calculation of the platymetric index, a measure of the flatness of the element, nine can be described as platymetric, or relatively ‘flat’, with values ranging from 67.2 to 84.5, while one is classed as eurymeric (Table 4; Figure 15). Playmeria is not uncommon in British prehistoric material, and so this is not unusual (Rogers, 1990, p. 188).

Fawcett (1922, p. 79) reports a right tibia with a platycnemic index of 60.5, and another 'extremely platycnemic' tibia is reported from later excavations (Davies, 1923, p. 6).

Cranial indices have been previously given as 70.3 for 'Skull No. 1', c. 74 for incomplete Skull 2 and 79.9 for Skull 3 (Fawcett, 1922, p. 80). This suggests considerable variation in cranial shape within a single population, with both dolichocephalic and brachycephalic (or nearly so) individuals represented, as is also remarked upon by Keith (1924). (By contrast most, though not all, Neolithic crania are dolichocephalic.) The reconstructed and newly designated 'Cranium 4' (M1.11.301) is dolichocephalic, with a cranial index of 72.0 (max. length 186 mm; max. breadth 134 mm) (Figure 14). Many of the fragments making up this cranium show earlier efforts at reconstruction, which may have been the work of Herbert Taylor (Davies, 1923, pp. 10-11), who also made photographs and drawings of lithics from the site at the time of the excavations (Jacobi, this volume).

Attempts to reconstruct stature are frustrated by the incomplete state of all of the long bones. Formulae are available for incomplete bones, but these produce imprecise estimates which severely limit comparative analysis. As reported earlier (Schulting and Wysocki, 2002), a probable female distal humerus segment indicates a stature of 143-159 cm. The stature of the far more complete contemporary Gough's Cave 1 (GC1, 'Cheddar Man') adult male has been reconstructed as c. 166.2 cm (Holliday and Churchill, 2003). These estimates are consistent with western European Mesolithic averages of  $151.3 \pm 4.6$  cm for females and  $163.1 \pm 5.8$  cm for males (Formicola and Giannecchini, 1999, Tab. 5). They are considerably shorter than



**Figure 15.** Four femoral shaft fragments (from left to right: M1.14.120, 115, 50, 60). M1.14.120 is right, all others are left. The two specimens on the left are probable males, those on the right probable females.

stature reconstructions for the Upper Palaeolithic, and form part of a well-documented secular trend of decrease in stature and also overall robusticity between the Palaeolithic and the Mesolithic (Formicola and Giannecchini, 1999; Frayer, 1980). The relatively gracile and short-statured characteristics of the Aveline's Hole population, then, are not unusual within the context of the period. Emphasising this gracility, Holliday and Churchill (1993) estimate that GC1 would have had a body mass of only *c.* 66 kg.

As with the skeletal measurements, molar crown dimensions are also very similar to values reported for European inland Mesolithic populations (Frayer, 1978) (Table 5).

Femur	Side	Description	<i>platymeric index</i>					
			<i>mid circ.</i>	<i>APD</i>	<i>Sex</i>	<i>ap</i>	<i>ml</i>	<i>index</i>
M1.14.:								
1	R	proximal shaft segment	*	*	indet	20.9	29.1	71.8
3	R	proximal end shaft; cortical erosion	*	*	indet	20.8	29.2	71.2
50	R	shaft; extensive cortical erosion	73.5	*	F?	23.8	28.3	84.1
60	R	shaft	73	23.9	F?	*	*	*
115	R	proximal 3/4 shaft; cortical erosion	78.5	*	M?	22.5	29.6	76.0
126	R	fragment head/neck; erosion	*	*	indet	*	*	*
140	R	shaft fragment, distal end	*	*	indet	*	*	*
150	R	midshaft segment; cortical erosion	76.5	*	indet	*	*	*
309	R	lateral condyle fragment						
15	L	distal midshaft	*	26.9	M?	*	*	*
43	L	proximal shaft fragment	*	*	indet	19.3	28.7	67.2
116	L	distal end, robust, erosion		*	M?	*	*	*
120	L	proximal 1/3 shaft; v.robust	*	*	M	28.6	31.7	90.2
130	L	proximal 1/4 shaft	*	*	indet	21.3	29.9	71.2
133	L	proximal 1/4 shaft; cortical erosion	*	*	M?	23.6	31.0	76.1
135	L	proximal 1/3 shaft	*	*	indet	21.1	29.8	70.8
139	L	conjoined w M1.14.62; shaft; erosion	75.5	*	indet	*	*	*
143	L	proximal 1/3 shaft; cortical erosion	*	*	indet	23.9	28.3	84.5
4	U	head/neck fragment	*	*	indet	*	*	*
7	U	shaft fragment	*	*	indet	*	*	*
66	U	shaft fragment	*	*	indet	*	*	*
80	U	shaft fragment	*	*	indet	*	*	*
147	U	midshaft fragment	77	*	M?	*	*	*
310	U	shaft fragment	*	*	indet	*	*	*

**Table 4.** *Osteometrics for Aveline's Hole femora.*

Tooth	Ave. Hole molar dimensions (mm)						Inland Euro. Mesolithic	
	mesio-distal			bucco-lingual			mesio-distal	bucco-lingual
	<i>X</i>	<i>l sd</i>	<i>n</i>	<i>X</i>	<i>l sd</i>	<i>n</i>	<i>X</i>	<i>X</i>
max. M1	10.5	0.62	10	12.4	0.36	9	10.5	11.9
max. M2	9.5	0.74	9	12.4	0.70	9	9.4	11.8
max. M3	8.4	0.44	6	11.2	0.79	6	8.4	11.3
mand. M1	11.4	0.56	8	11.1	0.42	7	11.3	10.9
mand. M2	10.7	0.75	6	10.7	0.30	6	10.5	10.6
mand. M3	9.8	0.17	3	10.6	1.30	3	10.4	10.1

**Table 5.** Molar crown dimensions for Aveline's Hole, sexes pooled (inland European Mesolithic pooled sex values from Frayer, 1978, table 21).

## PATHOLOGY

### *Skeletal pathology* (R Schulting and M Wysocki)

There is little that can be said regarding degenerative conditions, due to the poor survival of vertebrae and the articular surfaces on long bones. It is these elements that best record the onset and severity of degenerative changes that form the most common 'pathology' (though often reflecting only day to day wear and tear) in most prehistoric skeletal samples. A small number of vertebrae recorded in the catalogue were lost in the Blitz, while the few fragments that survive provide little information. Fawcett (1922, p. 79) notes the presence of 'arthritic disease' on a few cervical vertebrae, but no examples survive in the extant collection. A case of eburnation, indicating bone on bone contact, in the semi-lunar notch of a left ulna (M1.13.154) has already been noted (Schulting and Wysocki, 2002, Fig. 5). In addition, the olecranon fossa of a left humerus (M1.13.37+121) exhibits slight concentric lipping. Three elements (M1.13.177, 313, 324, a left clavicle, right humerus and left radius, respectively) show slight indications of reactive bone suggestive of periosteitis, or non-specific infection.

Cribriform orbitalia manifests as pitting in the roof of the orbit; it is an indication of childhood iron deficiency anaemia, whether brought about by dietary deficiency, disease, or high pathogen load (Stuart-Macadam, 1992). The condition is seen on three individuals at Aveline's Hole (M1.11.182, M1.11.301, belonging to 'Cranium 4', and A.H. 9, the last of uncertain attribution to the site) (Schulting and Wysocki, 2002, Fig. 4). The Aveline's Hole assemblage is so fragmentary and incomplete that it is difficult to use these to estimate overall prevalence for a comparison to other European Mesolithic assemblages or to earlier Neolithic assemblages in Britain. Fewer than 10 orbit fragments are sufficiently complete (and not obscured by calcium carbonate) to observe the condition, giving a prevalence of *c.* 25-35% depending on whether A.H. 9 is included, but little confidence can be put in this figure given the small sample size. This can be compared to figures for cribriform orbitalia noted at Neolithic sites such as Fussell's Lodge, where it was found to affect 20% of adults and 85% of children (Brothwell and Blake, 1966). The higher prevalence in children reflects, in part, the fact that the bone becomes remodelled in adults, obliterating earlier traces of the condition. Of course, higher infant mortality may also be experienced by children with iron deficiency anaemia, which could also account for the high incidence. However, the prevalence of cribriform orbitalia at Fussell's Lodge does seem to be unusually high and is not replicated at other British Neolithic sites (Brothwell and Cullen, 1991; Rogers, 1990; personal observation of earlier Neolithic material by the authors).

The external auditory meatus (the earhole) is observable on only five temporal fragments (M1.11.220, 309, 321, 325, and 326) and three crania, none of which show any indications of bony growths (exotoses) that are thought to result from repeated immersion in cool waters (*i.e.*, swimming and diving in rivers, lakes or the sea) (G. Kennedy, 1986). Thirty-four percent of individuals at the Mesolithic site of Vlasac in the Iron Gates Gorges exhibited this condition, though elsewhere in the European Palaeolithic and Mesolithic it occurs infrequently (Frayer, 1988).

No fractures indicating accidental or violent trauma were noted in the assemblage.

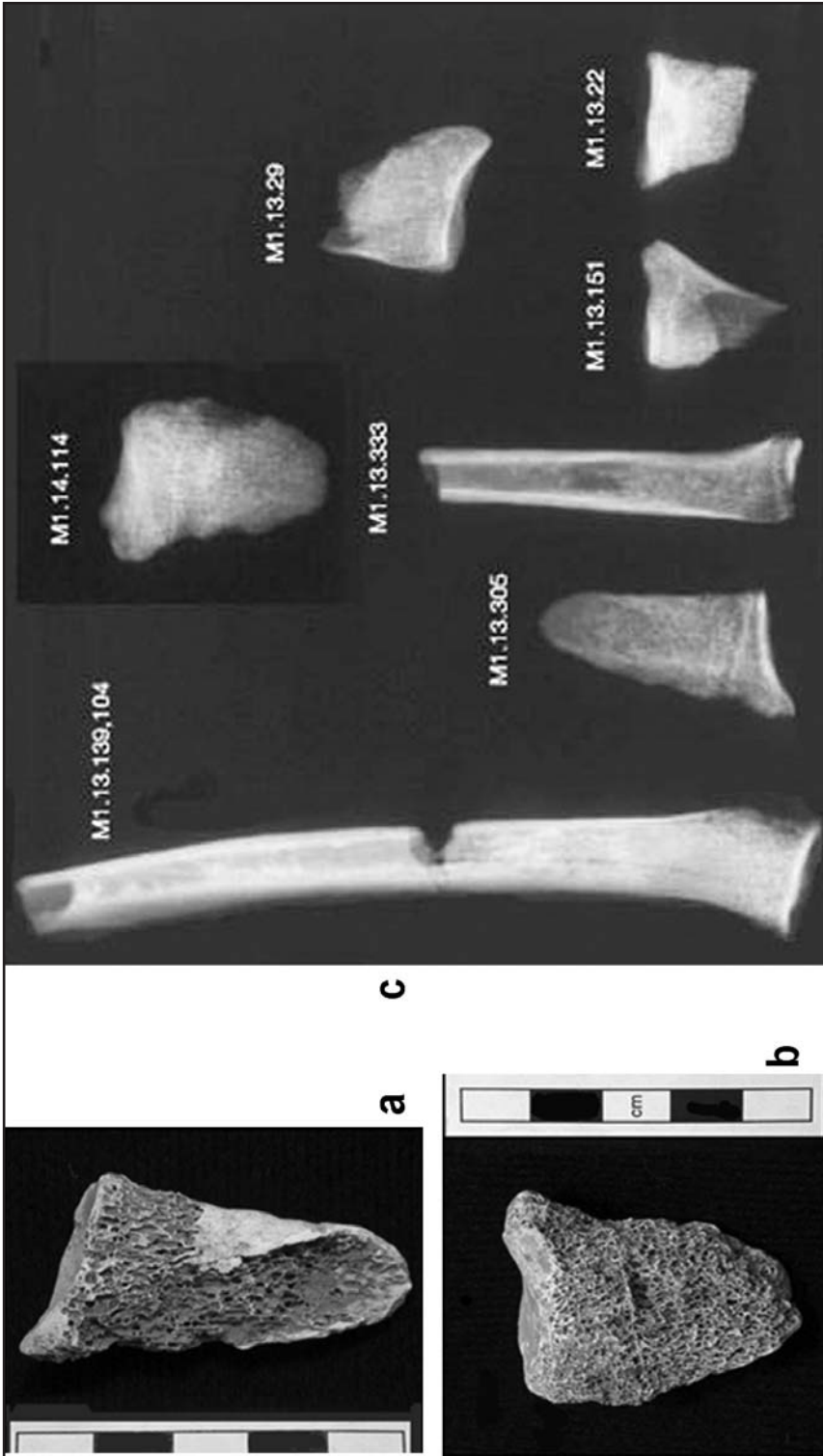
#### *Radiographic analysis* (B. Carver and R. Schulting)

Harris lines are radio-opaque transverse lines seen on radiographs, most commonly observed within the metaphysis of the tibia and distal femur in children. Harris, who first described these lines (Harris, 1931) attributed their formation to a temporary interruption in the normal longitudinal growth of the long bones during a period of illness or malnutrition. Some more recent research attributes these appearances to acceleration of bone growth post disease rather than the cessation of growth during the episode. In either case the presence of Harris lines can be used to infer a period of illness or nutritional disorder, but their precise aetiology is still the subject of debate (Ameen *et al.*, 2005; Vyhnanek and Stloukal, 1988). As these lines gradually disappear with bone remodelling over a decade or so (Hummert and van Gerven, 1985; Grolleau-Raoux *et al.*, 1997), studies of the presence of Harris lines in adult populations need to take this into account and be wary of drawing inferences about possible childhood conditions from this evidence alone. Interruptions in the growth of dental enamel, discussed below, are better suited to this, as they are not subject to remodelling.

Selected elements from the Aveline's Hole assemblage were radiographed at the School of Radiography, University of Wales, Bangor. Harris lines can be seen on two elements, a distal left radius (M1.13.305) and a proximal tibia (M1.14.114) (Figure 16). As it happens, the lines are visible even without the radiographs due to damage to the cortical bone. Unfortunately, it is not possible to address the timing of the episodes as the two elements are only small fragments. Harris lines are common in both prehistoric and historic populations. They are best used for comparisons within or between populations, but few radiographic studies have been undertaken for Mesolithic or Neolithic populations in Europe. Nor is it possible to estimate a rate of occurrence for Aveline's Hole given the few elements suitable for analysis.

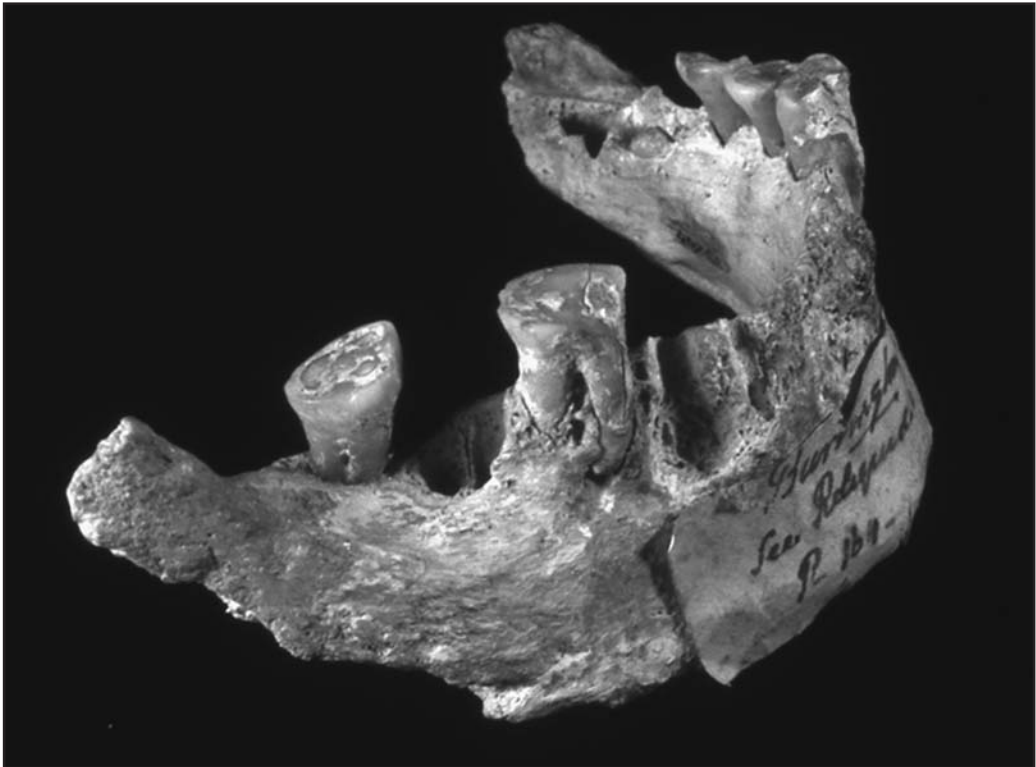
#### *Dental pathology* (R. Schulting and M. Wysocki)

Relatively little in the way of dental pathology exists on the extant material from Aveline's Hole. Hawkey (2003) similarly reports that the Gough's Cave 1 individual does not exhibit any dental pathology. As noted in the preliminary report, none of the loose teeth in the extant collection can be clearly scored as exhibiting caries (a total of 61 posterior and 24 anterior observable teeth). A cranium labeled A.H. 9 in the Wells Museum does have a carious lesion on its maxillary dentition, and three definite caries are present on a mandible that probably belongs to the same individual. However, the history of A.H. 9 is complex, and it is not certain that it belongs with the Mesolithic assemblage from Aveline's Hole (Balch, 1947; Meiklejohn, *pers. comm.*). Tratman (1922, p. 124) originally reported the presence of 'a number of carious teeth' though he did not quantify this. In any case, he subsequently came to realise that he was mistakenly scoring post-depositional erosion features at the cementum-enamel junction as carious lesions (Poole and Tratman, 1978). In the process 12 posterior teeth were sectioned, accounting for their absence in the surviving assemblage. Haile (1996) also reported a high incidence of caries (10% of 90 teeth), unusually including a number of claimed



**Figure 16.** Photographs (a,b) and radiographs (c) showing lines of interrupted growth (Harris lines) on (a) distal radius M1.13.305 and (b) proximal tibia M1.14.114 fragments.

examples on anterior teeth, but these have not been confirmed in the present study, and it is likely that these again represent post-depositional erosional features. Davies (1922, p. 114) records that several human teeth ‘show unmistakable signs of caries, and two apparently have their roots scraped or filed’, but both of these observations must be treated with caution. Caries are expected to be comparatively infrequent in mid- and high-latitude hunter-gatherers, due to both generally high attrition rates and to low carbohydrate and sugar in the diet (Meiklejohn and Zvelebil, 1991; Meiklejohn *et al.*, 1984).



**Figure 17.** *Mandible (EM 504) showing abscess at position of second premolar, as well as alveolar resorption.*

There is a low incidence of dental calculus in the surviving Aveline’s Hole assemblage, with no teeth recorded as showing more than ‘slight’ deposits, although it is possible that this reflects some degree of post-excavation cleaning. Identification of the condition is also complicated by occasional adhering calcium carbonate deposits. Calculus deposition is typically expected to be relatively high in populations with high-protein diets, although the processes leading to its formation are complex and cannot be said to be entirely understood (Lieverse, 1999).

Abscessing is seen on one of the few surviving mandibles (EM 504) at the position of the second premolar (Figure 17). The same mandible shows considerable alveolar resorption, indicative of periodontal disease. In addition, the UBSS catalogue includes information on



specimens that were lost in 1940. While this must be treated cautiously, the identification of conditions such as abscessing and antemortem tooth loss is fairly straightforward and can be accepted. Thus, for example, the catalogue records an abscess on the posterior root of a mandibular left second molar (M1.11.116). Similarly, a missing mandible fragment reportedly shows the antemortem loss of the second and third molars 'at least 12 months prior to death'. In fact, given the paucity of surviving maxillae and mandibles, this is the only evidence for antemortem tooth loss in the assemblage, although presumably the condition was not uncommon.

Reactive roots appear to be quite a common condition in the Aveline's Hole dentition (e.g., M1.11.89, 90, 195, 125) (Figure 18). This takes the form of irregular, light-coloured cementum at the root tip, and may indicate chronic peridontitis (Tratman, 1922, p. 124) or it may be in part a response to heavy mechanical loading. This need not be at odds with the relatively low attrition seen in wear stages and also suggested by the microwear analysis (see McLaughlin, below), since the reactive roots are often seen in the anterior dentition (molar M1.11.125 is an exception), while microwear studies were undertaken on molars.



**Figure 18.** Selection of teeth showing reactive roots (M1.11.125, 89, 90, 195).

A number of surviving teeth show clear horizontal bands across the enamel, a condition known as linear enamel hypoplasia (LEH). These interruptions are the result of some childhood stress, whether nutritional or disease-related, occurring during the development of the tooth in question (Goodman *et al.*, 1984; Goodman and Rose, 1991; Huss-Ashmore *et al.* 1982). Enamel hypoplasia is more commonly found in the anterior teeth. It is seen here in eight of the extant 26 loose anterior teeth, providing an incidence of 30.8%, though a number of these lines are very faint and identification is not entirely secure. Lines are very clear on five teeth (19.2%) (Figure 19). Of the 26 teeth, however, nine do not retain sufficient enamel to

allow observation: omitting these results in an incidence of 47.1%, or 29.4% including only the most secure examples. Including teeth missing in the UBSS catalogue does not substantially change this figure, particularly as Tratman reports four of these as themselves exhibiting LEH (all on anterior teeth). The incidence becomes 40% (12/30) for the anterior dentition, excluding known unobservable teeth. Four of 23 observable premolars also show LEH, while a number of additional posterior teeth show irregularities in their enamel formation that can also be related to growth disruption (e.g., M.I.11.198), and in fact may reflect a more severe stress, since it occurs later in childhood. Combining both the surviving anterior and posterior teeth with observable enamel (12/100) gives an overall incidence of 12%.

The calculations above refer to the percentage of affected teeth, and some of these may of course belong to the same individuals (indeed, this would be expected); moving from this to the percentage of the population affected is difficult when dealing with isolated teeth. Nevertheless, some figures may be tentatively proposed. Three of the anterior teeth with LEH are identified as probable left mandibular canines, so at least three different individuals are affected. The dental MNI (taking into account tooth, side and wear stage) is 15, this is based on molars, which are better represented but less likely to manifest the condition, suggesting that a minimum of 20% of the individuals were affected.



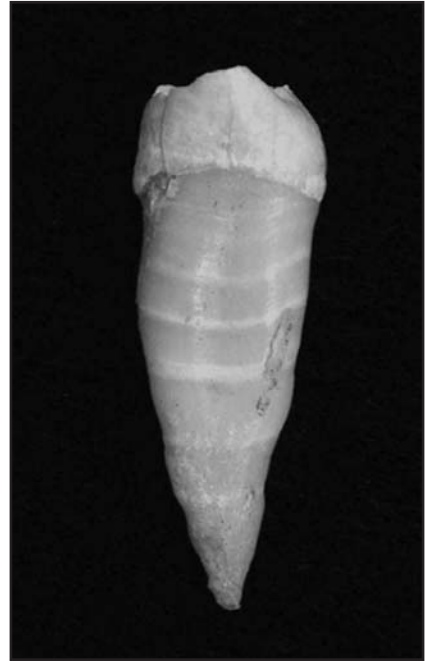
**Figure 19.** *Strongly marked linear enamel defects (enamel hypoplasia) on teeth M1.11.5, 243, 228, 244 and 89, suggesting episodic nutritional or disease stress during childhood.*

Comparing the number of affected teeth at Aveline's Hole (12%) with southwest British Neolithic values, a combined incidence of *c.* 4.4% is seen at Ty Isaf, Penywyrlod, and Hazleton North, three earlier Neolithic Cotswold-Severn tombs (Rogers, 1990, pp. 190-191; Wysocki and Whittle, 2000, p. 592). This difference in the number of affected teeth is

statistically significant ( $\chi^2 = 8.42$ ,  $p = 0.004$ ). To judge by LEH, then, the Mesolithic population of Aveline's Hole may have experienced somewhat higher levels of childhood stress than Neolithic communities in the same general region. Still, caution is warranted until the condition has been more widely studied for both Mesolithic and Neolithic populations. Wider Neolithic comparisons show greater variability; for example, six of 29 individuals show LEH at Fussell's Lodge (Brothwell and Blake, 1966), compared with only two of 75 individuals at Hambleton (McKinley, 1996, cited in Roberts and Cox, 2003, Tab. 2.5).

Since teeth develop at a known rate, the timing of interruptions in the deposition of enamel can in theory be estimated from their position relative to the crown-root junction. In practice, however, there is too much individual variability in growth rates to do this with any precision (Goodman and Rose, 1991; Hillson, 1996, pp. 172-176). In addition, detailed data on growth are often available only for mandibular teeth, and even these can exclude incisors (Scheuer and Black, 2000, p. 159), which present one of the more commonly affected tooth types. With these caveats in mind, it is possible to make some tentative estimations of the general timing of growth interruptions (Table 6). Of particular interest is the apparently episodic nature of stress indicated by four teeth each with multiple, strongly marked linear defects (M1.11.5, 89, 243 and 244) (Figure 19).

The clearest and strongest lines are found on a maxillary incisor (M1.11.244), although measurement of the line furthest from the cementum-enamel junction (c.e.j.) is made difficult by damage and an uneven glue join. Nevertheless, taking this tooth as an example, there is a clear line very near the c.e.j., with another some 2 mm above that, and a third some 3-4 mm above that, near the middle of the labial surface of the tooth. These suggest interruptions in growth at the ages of approximately 3.9, 3.4 and 2.9 years, respectively. Again, these should be seen as very approximate estimations only, with at least a  $\pm$  six month uncertainty. But what this and the other teeth with multiple LEH do seem to indicate is a recurrent stress apparently occurring at less than a yearly interval, between the ages of about three or four and six (Table 6). Stress operating at a yearly interval might be expected to be related to seasonal food shortages, particularly in a highly seasonal north-temperate environment where late winter and early spring are often difficult times of the year. It is unclear what environmental stress might operate on less than a yearly cycle, although there are so many uncertainties with the estimation of the timing of disruptions that they still could conceivably be yearly. Alternatively, the growth disruptions could reflect repeated bouts of illness not directly related to the time of year. A number of roots shows distinct opaque white bands; these can be seen most prominently on a maxillary canine (M1.11.164), showing six or seven such bands (Figure 20). Relatively little seems to be known concerning these bands, and those as pronounced as the



**Figure 20.** *White bands on root of maxillary canine (M1.11.164) suggesting episodic interruptions of growth in older childhood (c. 7-11 years).*

Aveline's Hole example are rare. Whatever their precise formation process, they appear to be the root equivalent of LEH, and suggest repeated episodes of stress leading to interruptions in growth, but in later childhood, as this is when the roots are forming. In the case of the maxillary canine, these interruptions are occurring between the ages of 6 and 11, and may very well mark a yearly seasonal stress such as food or specific nutrient shortages.

Aveline's Hole teeth exhibiting a single LEH (of course additional lines may have been present but lost due to occlusal tooth wear) also occur between about three and six years of age. Interruptions in growth in this age range could conceivably relate to stress during weaning, which is often late in hunter-gatherers, or perhaps to particularly bad seasonal shortages to which growing children would be especially susceptible. This is speculative, but would warrant future investigation.

<i>Catalogue</i>	<i>Tooth</i>	<i>Distance from c.e.j. (mm)</i>	<i>Estimated age of interruption</i>	
M1.11/5	mand. C?	c. 2.5	4.3	
		4.0	3.5	
M1.11/89	max. C	1.0	5.1	
		2.1	4.5	
		3.1	3.9	
		4.1	3.0	
M1.11/93	max. PM1/2	final 1/3	4 to 6	
M1.11/128	max. PM2	2.1	5.0	
M1.11/163	max. I1	2.7	3.1	
M1.11/164	max. C	not recorded		
M1.11/195	mand. C	3.1	4.0	
M1.11/196	mand. C	3.1	4.0	
M1.11/222	mand. I2?	2.4	2.7	
M1.11/228	mand. PM2?	0.5	6.3	
M1.11/243	mand. PM1/2	1.1	4.9/5.8	
		(first age estimate if PM1,	2.1	4.2/5.1
		second if PM2)	3.1	3.6/4.5
M1.11/244	max. I1	0.8	3.9	
		1.8	3.4	
		2.8	2.9	

**Table 6.** Age estimates for interruptions in growth indicated by linear enamel hypoplasia (using data in Goodman and Rose 1991, Fig. 3). These should be read as very approximate estimates only.

#### ACTIVITY MARKERS (R. Schulting and M. Wysocki)

Efforts to investigate skeletal evidence for habitual activities in the Aveline's Hole assemblage were largely frustrated by the partial and fragmentary nature of the assemblage, affecting both individual elements and the ability to identify different elements from the same

individual. Cortical erosion also presents difficulties. Quantification was limited to an attempt to assess musculoskeletal stress markers (MSM) for selected elements. These refer to areas of the bone to which major muscle groups are attached. The expression of a muscle attachment site is graded from 0 to 3 (least to most marked) for robusticity (R), and from 1 to 3 for the presence of stress lesions (S), indicating excessive strain on the muscle attachment site. Repeated strong use of the muscle group over a period of years will bring about a larger and more rugous attachment site on the bone (Hawkey and Merbs, 1995). This can provide an indication of the kinds of activities (often only in a very general sense) undertaken on a regular basis by an individual.

UBSS cat. no.	Side	Sex	MSM: ulnae					pollus longus			
			<i>flex. dig. sup.</i>	<i>pron. teres</i>	<i>brachialis</i>	<i>supinator</i>	<i>triceps</i>	<i>anconeus</i>	<i>flexor</i>	<i>extensor</i>	<i>abductor</i>
M1.13.144	L										R2
M1.13.152	L	M?	R3	R3	(R3)S1	R2			R3	R2	R3
M1.13.154	L	M?	R2	R1	R3	R2		R2			
M1.13.163	L	F?	R1	0	R1	R1/2	R1	R1/2	R2		
M1.13.164	L	F?	0	0	R1	0					
M1.13.166	L			R2	R2	R2	R2	R2			R2
M1.13.172	L	F?			R1						
M1.13.300	L				R2					R1	R2
M1.13.302	L	M?			R3+	R2				R2	R3

UBSS cat. no.	Side	Sex	MSM: femora		adductor		vastus	
			<i>gluteus max.</i>	<i>pectineus</i>	<i>mag.</i>	<i>brev.</i>	<i>med.</i>	<i>lat.</i>
M1.14.1	R		R3					
M1.14.50	R	F?	R2	R2			R1	R2-
M1.14.115	R		R3	R3			R2	
M1.14.120	L	M	(R3) S1/2	R2/3	R2/3	R2/3	R2	
M1.14.130	L		R2					
M1.14.133	L	M?	(R3) S1/2	R3	R3	R3	R2	
M1.14.135	L		R3		R2	R2	R3	

**Table 7.** Musculoskeletal stress marker (MSM) scores for selected Aveline's Hole ulnae and femora.

MSM scores were measured for a group of femora and left ulnae (Table 7). Very few specimens were scored, and so the results are tentative. There is an impression that, of the very few elements that can be confidently sexed, MSM scores are significantly higher for males, though this would not be unusual (males tending to have higher MSM scores in general). More interesting is that the Aveline's Hole presumed male scores are higher than those for two earlier

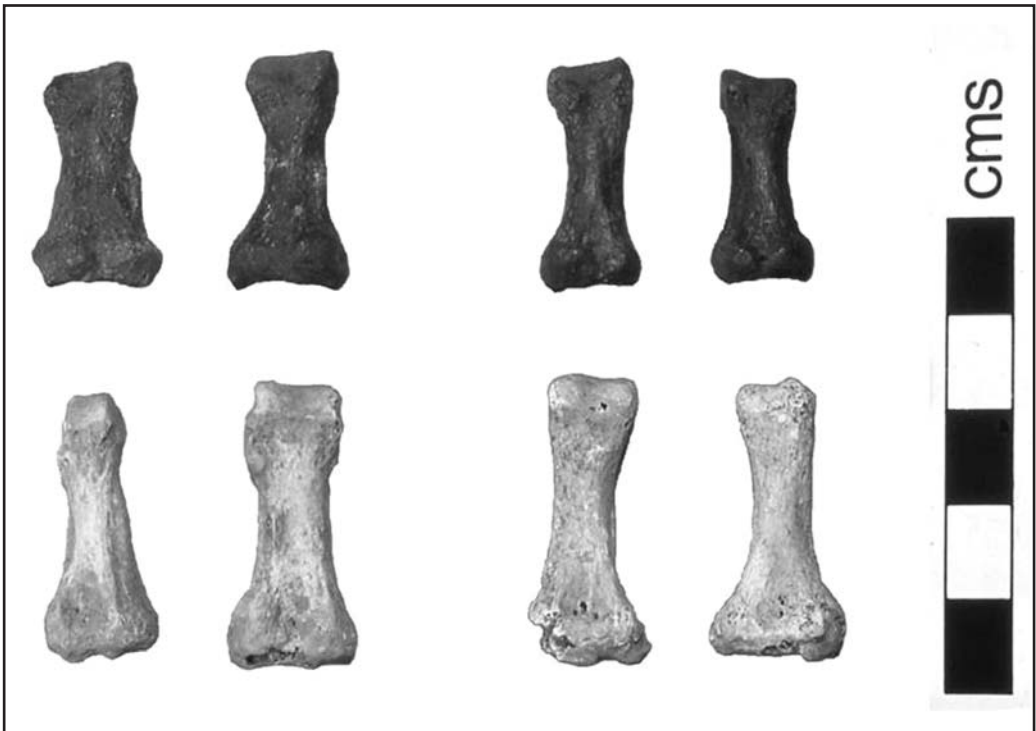
Neolithic sites in southern Britain (Wysocki and Whittle, 2000) for those muscle attachment sites for which data are available (in particular, *pronator teres* and *brachialis* on the ulna, and *gluteus maximus* and *pectineus* on the femur).



**Figure 21.** Selection of Aveline's Hole left ulnae showing gradation in size presumed to relate largely to sexual dimorphism (from left to right: M1.13.154, 152, 163, 172, 160).

As noted above, with one exception (M1.14.120), all measurable femoral specimens show some degree of platymeria (anterio-posterior flattening of the proximal femoral shaft: indices of  $<85.00$ ), the majority pronounced. The condition is generally regarded as an indicator of biomechanical stress, with well documented worldwide temporal trends of decreasing flattening associated with transitions from prehistoric hunting-gathering, to settled agriculturists, to industrial populations (Larsen, 1997, pp. 222-223). Similarly, observable femoral muscle insertion sites are rugous and enthesopathic (denoting bony growth at the site), notably *gluteus maximus*, *pectineus*, the adductors and *vastus medialis* (muscles involved in adduction and extension of the hip and knee). There is not enough data to comment on any possible sexual dimorphism in these behavioral markers. The apparent greater development of the leg muscles at Aveline's Hole would be consistent with a more mobile lifestyle in the Mesolithic, though the numbers involved are far too low to test this impression more rigorously. A degree of variability would be expected between individuals, and in this regard it is worth noting that Gough's Cave I has only moderate muscle markings on its femora (Trinkaus, 2003). The analysis of MSM scores for Aveline's Hole was not exhaustive and further work might usefully be done, though again subject to the limitations noted above.

Powerful use of the forearm is further confirmed by the hypertrophy of the supinator crest seen in a proximal right ulna (M1.13.143), and this has been associated with repeated activities involving supination and hyperextension of the arm. Two left ulnae (M1.13.152, 154) also show strong development of the supinator crest, possibly indicating that whatever activity was involved, was not restricted to the right arm (left-handedness would be another option that could maintain bilateral asymmetry) (Figure 21). A well-marked radial fossa on a left humerus (M1.13.37+121) also suggests powerful rotational use of the forearm, which in this case was beginning to lead to arthritic changes, seen in lipping around the fossa. Throwing motions, such as for a spear, would be one possibility for the observed bony changes (Kennedy, 1983).



**Figure 22.** Proximal phalanges of the foot show wedging of the epiphyses (on left, M1.14.318; normal on right, M1.14.319) relating to habitually flexing the toes downwards.

Overall the surviving elements indicate a fair degree of variation in the levels of habitual activities indicated; in large part this may be attributable to sexual dimorphism (and/or gender-linked differences in day to day activities), though the argument can easily become circular when the elements in question cannot be independently sexed. What can be said is that a number of individuals appear to show heightened levels of habitual loading on their limbs and that the left upper limbs seem as likely to be affected as the right. The young adult male Gough's Cave 1, dating to the same period as the Aveline's Hole humans, while described as

being overall quite gracile, is noted as exhibiting asymmetrical development of the right clavicle, without concomitant robusticity in the rest of that arm (Churchill, 2001). The explanation for this, and what activity it might reflect, is unknown. The surviving hand bones from this individual are noted as being generally gracile (Trinkaus, 2001). At least some individuals from Aveline's Hole appear to show more strongly developed bones of the hand, including a left metacarpal I (M1.13.346) exhibiting a sharp hypertrophic ridge for the insertion site of the interosseous muscle.

A number of proximal phalanges of the foot show wedging of the epiphyses (Figure 22), indicating strong and habitual plantar flexion (pushing the foot downwards). A very similar condition has been noted by Molleson (1989, Fig. 5) at the Near Eastern Early Neolithic site of Abu Hureyra. It is unlikely that a similar explanation can be invoked, in the specific sense of seed grinding. But it is possible that an activity involving a similar kneeling and pushing position did occur, such as would be involved with scraping skins placed on the ground. Such activities may well have been gendered, but the elements involved are not determinable as to sex.



**Figure 23.** *Molars (from left to right: M1.11.8, 223, 924) with interproximal grooves (a) showing fine parallel striations (b) relating either to the palliative use of 'tooth picks' or to working plant or animal fibres through the teeth during manufacturing of thread.*



So-called squatting facets are found on the single complete right talus (M1.14.146), and on two of the three left tali (M1.14.121 and 138). These facets are relatively common in prehistoric skeletal populations, and simply result, as the name suggests, from the habit of squatting on one's haunches rather than, for example, sitting cross-legged or on a stool. This need not be related to any specific activity.

Another kind of activity is indicated by interproximal grooves on three or possibly four molars (M1.11.4, 8, 223, 924) (Figure 23a). Tratman proposed an additional three examples, but two of these (M1.11.4, 230) appear to be more consistent with post-depositional erosion features, while the other (M1.11.234) was sacrificed by Tratman to determine its percent organic content. Light and scanning electron microscopy on three of the four extant examples confirms the presence of fine parallel striations running the length of the grooves (Figure 23b), which must result from the repeatedly pulling some material between the teeth. All of the examples, including the missing tooth, are on maxillary molars and the groove is placed mesially in all but one of the four surviving examples. Often called 'tooth-pick' grooves, such features have been recorded from many parts of the world, including Middle (e.g., the La Quina and Krapina Neandertals,) and Upper Palaeolithic (e.g., Grimaldi) European hominids (Frayar and Fox, 1997; Formicola, 1988). Cross-culturally, they generally appear to be more common in males than in females (Brown and Molnar, 1990), though it is not possible to determine the sex of the Aveline's Hole examples. The reasons for their formation have long been debated, with the two main contenders being a form of dental hygiene (as implied by the term 'tooth-pick groove'), or a repetitive task involving the pulling of sinew or plant fibres through the teeth in preparation for making cordage (Brown and Molnar, 1990; Frayer, 1991; Larsen, 1985; Milner and Larsen, 1991; Pedersen and Jakobsen, 1989; Willey and Hofman 1994). The latter position has been argued by Brown and Molnar (1990) in the context of a prehistoric Australian Aboriginal sample exhibiting frequent interproximal grooves. In this case, their interpretation is greatly strengthened by film recordings of just this activity. This view emphasises the importance of preparing thread in prehistoric societies, which would surely have been a crucial item for a multitude of purposes, ranging from the manufacture of clothing to bowstrings, nets and traps. However, the Aveline's Hole grooves are on the second and third molars, and it is difficult to see how thread could have been easily worked this far back in the mouth in the way required (cf. Frayer, 1991). Thus, it is possible that they do represent 'tooth-pick' grooves.

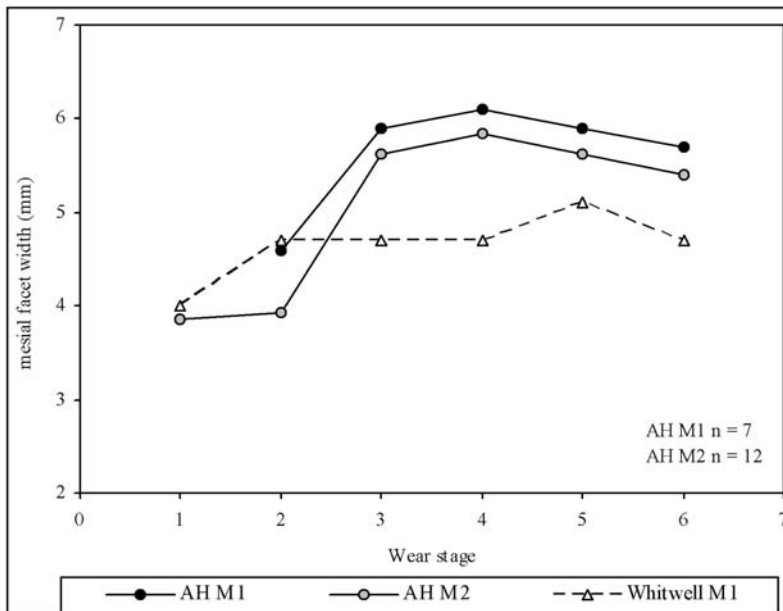
At least two incisors (M1.11.163, 192) shows parallel striations on their labial surfaces and increased wear to the middle anterior part of the occlusal surfaces that could reflect the working of sinew or plant fibres (cf. Milner and Larsen, 1991; Molnar, 1972; Schulz, 1977)



**Figure 24.** *Incisor (M1.11.192) with parallel striations on its labial surface and increased wear to the middle anterior part of the occlusal surface possibly reflecting the working of sinew or plant fibres.*

(Figure 24), or using the mouth as a ‘third hand’ holding materials being worked. A similar explanation may apply to the antemortem chipping of the enamel seen on a small number of anterior and posterior teeth. This would apply particularly to the anterior example (M1.11.163), while posterior examples (M1.11.194, 247, possibly also M1.11.4) could relate either to the occasional presence of grit in the diet (a small stone), or to non-dietary use of the teeth. A maxillary molar from the Gough’s Cave 1 individual also exhibits chipped enamel (Hawkey, 2003).

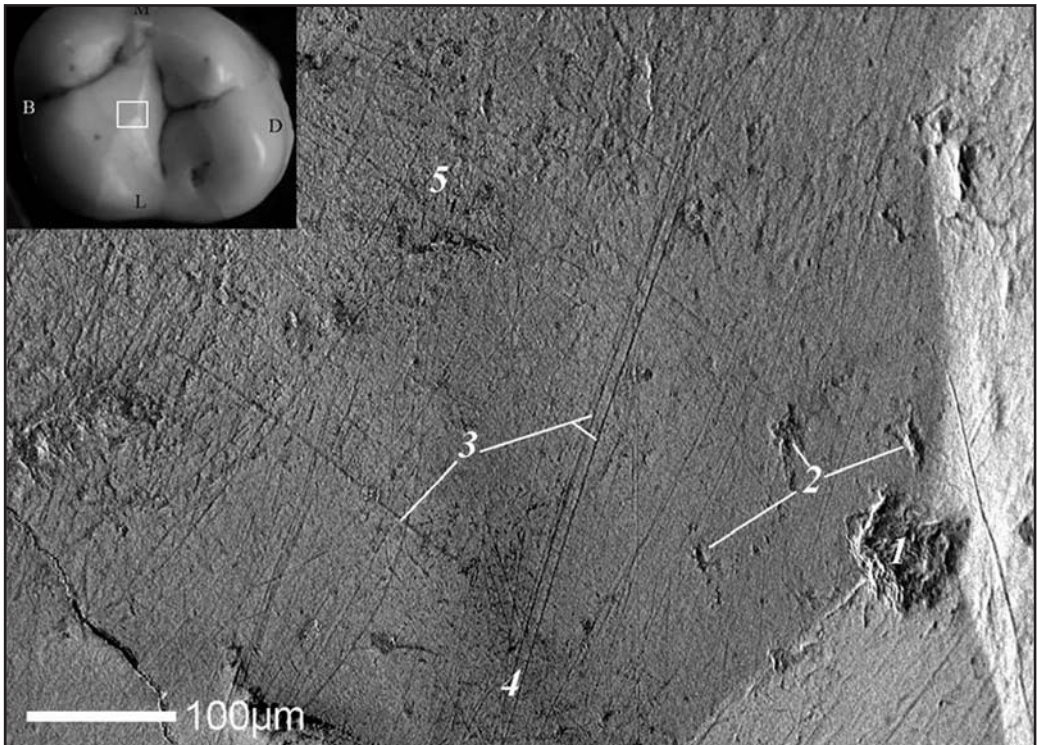
Various kinds of activity relating to diet are also evident on the teeth. Dealing with loose teeth limits some of the information to be gained. For example, it is more difficult to accurately measure angle of wear without the plane of the mandible or maxilla to relate to the occlusal tooth surface. As a general observation the wear seems relatively flat, as expected in hunter-gatherers (B. Smith, 1984), but this finding is tempered somewhat by the relative paucity of older individuals that tend to show more extreme wear patterns. One observation that is actually facilitated by having loose teeth is the measurement of mesial and distal wear facets on the molars. These facets are thought to relate in part to the intensity of mastication, though it seems reasonable to also expect a strong influence from dental crowding, which, considering the small size of the surviving mandible fragments, may have been a factor at Aveline’s Hole. A comparison of the mesial facet width in relation to wear stage between first molars from Aveline’s Hole and the Early Neolithic site of Whitwell, Derbyshire (Chamberlain and Witkin, 2003), shows that, once wear stage 3 is reached, the mesial facet width is consistently greater in the Aveline’s Hole teeth (Figure 25). This suggests a more intensive chewing regime at the Mesolithic site, which to some extent contradicts the dental microwear results (see McLaughlin, below). Clearly, further research is required to see how these different dietary proxies relate to one another.



**Figure 25.** Mesial facet width in relation to wear stage on Aveline’s Hole first and second molars compared to first molars from Early Neolithic site of Whitwell (Whitwell data from Chamberlain and Witkin, 2003). Wear stages after B. Smith (1984).

## DENTAL MICROWEAR (R. McLaughlin)

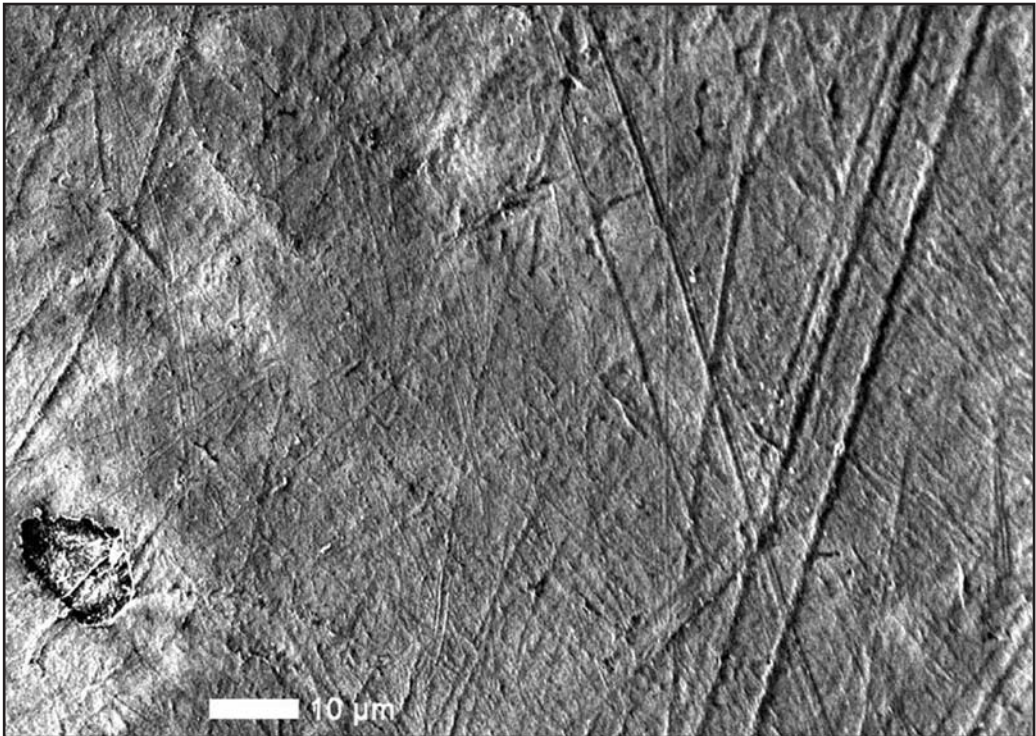
Some aspects of dietary behaviour can be investigated using dental microwear analysis, which refers to the study of microscopic marks on human occlusal tooth surfaces caused by small, hard objects in food. Haile (1996) examined three human molars from Aveline's Hole for dental microwear and found patterns suggesting a mixed diet including plant remains, though the interpretation of the results was hampered by the lack of appropriate comparative studies. Recent years have seen several methodological advances in dental microwear analysis (e.g. Gügel *et al.*, 2001; Maas, 1994; Ungar 2002). It is now possible to say more concerning the agents that cause microwear features (Danielson and Reinhard, 1998; Teaford and Lytle, 1996). Furthermore, some studies have demonstrated that populations with only slightly different diets can exhibit significantly different microwear patterns (Nystrom and Cox, 2003; Schmidt, 2001; Ungar and Spencer, 1999). This contribution aims to re-evaluate dental microwear from Aveline's Hole in light of these advances and to compare the site with new microwear studies of the Late Mesolithic cemetery at Téviec in Brittany, and the early Neolithic Cotswold-Severn chambered tomb of Belas Knap in Gloucestershire.



**Figure 26.** SEM photomicrograph of mesiolingual cusp of tooth M1.11.386 from Aveline's Hole at 100x. Indicated are (1) a large pit on cusp tip; (2) large pits near the top of the cusp; (3) very long scratches; (4, 5) areas populated by features of various different shapes.

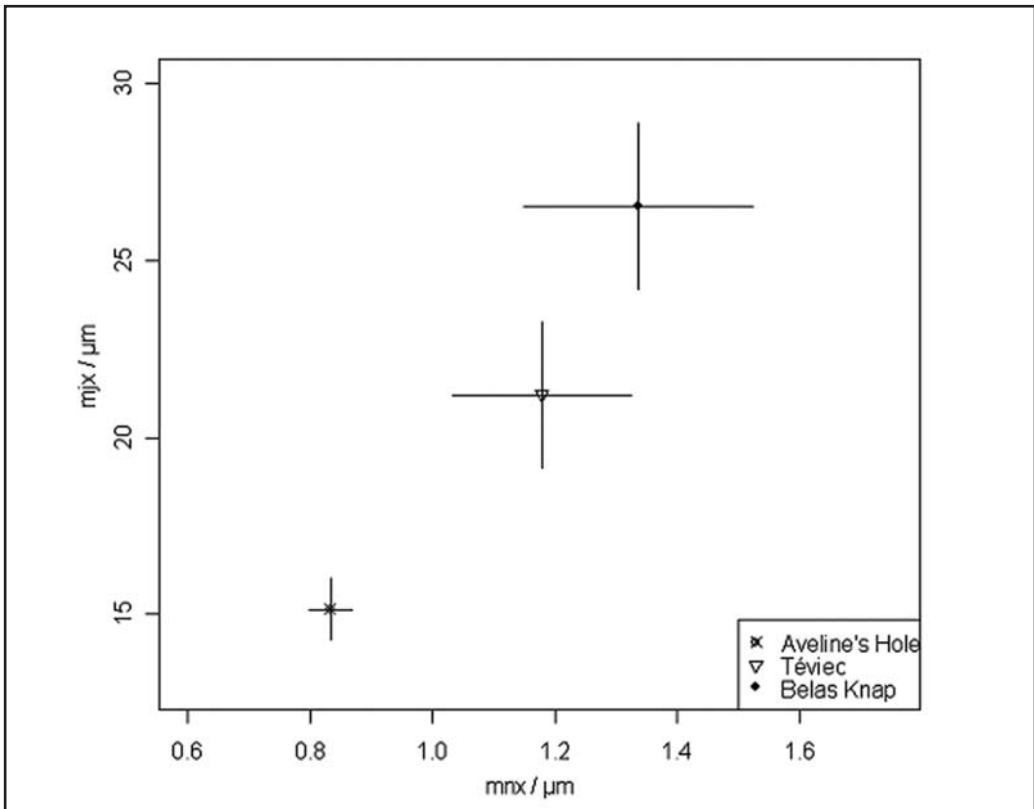
### *Methodology*

Dental microwear analysis has been employed as a tool for reconstructing past diets for over 30 years (Teaford, 1991). In this time, no standard procedure has emerged among researchers and currently a number of techniques are used (cf. Gügel *et al.*, 2001; Nystrom and Cox, 2003; Pérez-Pérez *et al.*, 2003; Schmidt, 2001; Ungar *et al.*, 2003). In the current study, positive copies of seven maxillary second molar teeth from Aveline's Hole were examined using a Jeol JSM-6400 SEM at Queen's University Belfast. Microwear regions on the occlusal surface were identified at low magnification (Figure 26) and images for further analysis were taken at 500x (Figure 27). Eighteen of these photomicrographs, each representative of 0.032mm<sup>2</sup> of occlusal surface, were taken over strategic areas of occlusal surface and all the microwear features thereon were identified and measured in terms of their length (*mjx*) and width (*mnx*) using the *Microware* package (Ungar, 2002). Further computer utilities were written in *R* (R Development Core Team, 2004) to produce and analyse continuous distributions of *mnx* and *mjx*, and measurement error rates were investigated but did not approach statistical significance (see McLaughlin, 2004 for full details). For purposes of comparison, nine photomicrographs from three molar teeth from the Cotswold-Severn chambered tomb of Belas Knap in Gloucestershire and five photomicrographs from two molar teeth from the Late Mesolithic coastal cemetery of Tévéc in Brittany were obtained and analysed in a similar manner.



**Figure 27.** SEM photomicrograph at working magnification (500x) taken near region 4 on Figure 26.

A  $mnx : m_jx$  ratio of at least 1:4 was used to classify microwear features as pits, with remaining features classified as scratches. A distinction between hard and tough foods can be made by counting the relative number of 'pits' to 'scratches', which is an approach taken in much of the literature on dental microwear (Gordon, 1988) and such an approach was taken during previous microwear work performed by Haile (1996). However, many prehistoric populations tend to produce similar pit-scratch ratios (Nystrom and Cox, 2003), so a more detailed approach is called for here. Variables analysed were pit  $m_jx$ , or length (which is proportional to pit width), scratch  $m_jx$  (length) and scratch  $mnx$  (width).



**Figure 28.** Dental microwear scratch width ( $mnx$ ) versus scratch length ( $m_jx$ ) for Aveline's Hole and the comparative sites. Plotted are median values  $\pm$  95% confidence interval of the median. Tévéc and Belas Knap have statistically similar scratch widths but distinctive lengths. The Aveline's Hole dentition has by far the shortest and the thinnest scratches.

### Results

Details of the teeth included in this study and the amount of microwear data recovered from each are presented in Table 8. Two molars displayed no microwear (M1.11.3 and 193). This may be due to an acidic diet, episodes of emesis before death, post-depositional erosion or post-excavation cleaning or treatment of some kind (King *et al.* 1999; Schulting, *pers. comm.*; Teaford 1988). Results from each individual are not detailed here (see McLaughlin, 2004), but most individuals clustered around the site average. One tooth from Aveline's Hole (M1.11.247)

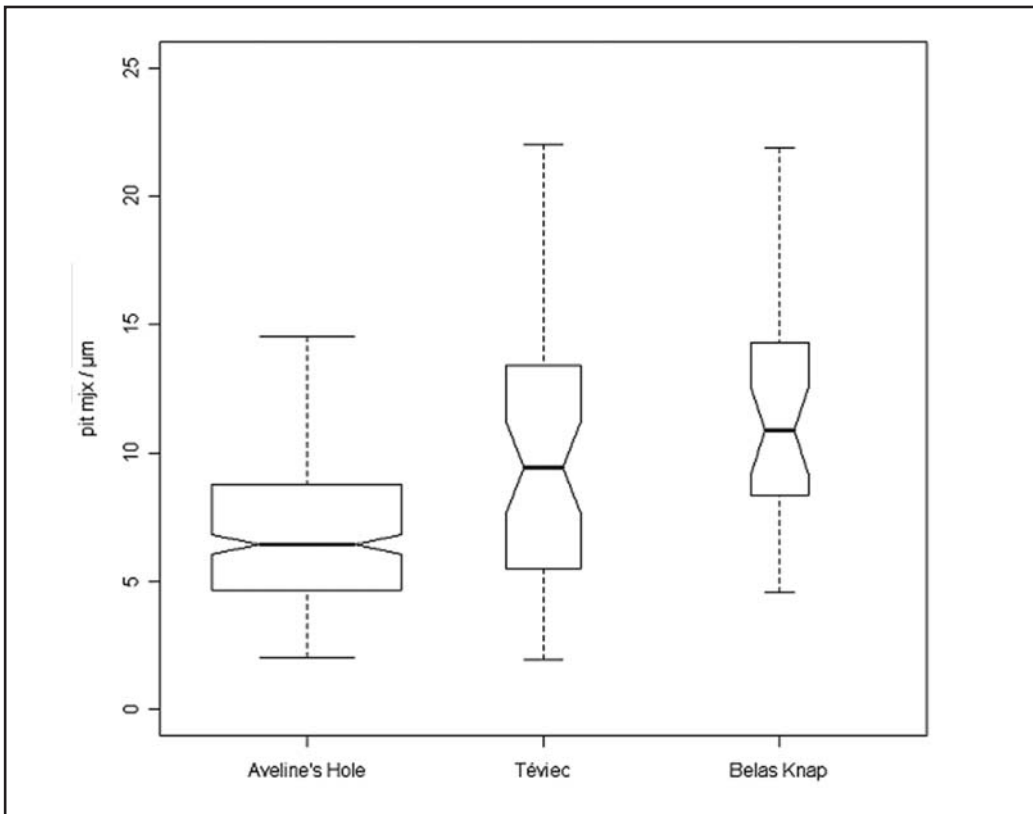
had larger and fewer microwear features than the site average, which may represent a dietary difference or post-depositional erosion, where smaller features are obliterated by their deposition context (King *et al.*, 1999). Many of the skeletal elements from Aveline's Hole exhibit loss of cortical bone surfaces, and some show severe geochemical erosion (see Schulting and Wysocki above). Erosional features have also been noted specifically on the teeth, and are responsible for earlier claims for a significant proportion of caries at the site (Poole and Tratman, 1978).

All three sites had a similar number of pits relative to scratches. Aveline's Hole had  $80 \pm 17\%$  scratches, Téviec  $81 \pm 19\%$  scratches and Belas Knap had  $82 \pm 16\%$  scratches (mean  $\pm$  s.d.). The abundance of scratches at all three sites is significantly greater than other prehistoric groups studied by Nystrom and Cox (2003) and similar to a Late Archaic population from Indiana in North America studied by Schmidt (2001).

<i>Tooth or fragment identifier</i>	<i>Position</i>	<i>Number of used photomicrographs</i>	<i>Total number of microwear features</i>
<i>Aveline's Hole</i>			
UBSS M1.11.387	R Max M2	3	160
UBSS M1.11.386	R Max M2	10	1116
UBSS M1.11.247	R Max M2	2	53
UBSS M1.11.152	L Max M2	2	118
UBSS M1.11.145	L Max M2	1	140
UBSS M1.11.3	R Max M2	0	No microwear
UBSS M1.11.193	R Max M2	0	No microwear
<i>Téviec</i>			
2-2	L Max M2	1	58
16-3	L Mand M2	4	234
<i>Belas Knap</i>			
Duckworth Eu.1.2.12	R Mand M2	5	215
Cheltenham 1979:1298	L Mand M2	2	104
Cheltenham 1978:710	L Max M2	1	42

**Table 8.** Details of teeth analysed and numbers of photomicrographs and microwear features.

A plot of median scratch  $mjx$  versus  $mnx \pm 95\%$  confidence interval for both variables is given in Figure 28. Figure 29 shows pit box and whisker diagrams of pit  $mjx$ . An estimate of the significance of how the medians of each site's  $mjx$  or  $mnx$  pit and scratch distributions differ may be read directly from these plots using the medians' 95% confidence intervals (cf. Chambers *et al.*, 1983). The median is the preferred summary statistic of these data because the variables are not normally distributed. Between-site differences between the distributions were also tested using the Kolmogorov-Smirnov test, which finds that the scratch  $mnx$  variables from all three sites in the study are significantly different ( $p < 0.01$ ). Scratch  $mjx$  is similar for Belas Knap and Tévéc ( $p = 0.14$ ), but significantly shorter at Aveline's Hole ( $p < 0.01$ ). Pit  $mjx$  results show similar significant differences between the Aveline's Hole dataset and the other sites ( $p < 0.01$ ) but not between Belas Knap and Tévéc ( $p = 0.11$ ). This confirms what can be gleaned from the results visually.



**Figure 29.** A box and whisker plot of the length ( $mjx$ ) of pits. Pit length is generally proportional to pit width. Aveline's Hole has significantly smaller pits than the other two sites.

#### Discussion of the microwear

The Aveline's Hole dentition shows the least severe microwear signature in the three prehistoric groups studied here. The main agents held responsible in the literature for generating microwear features are plant phytoliths, ambient grit from processing cereal artifacts and sand or soil particles adhering to the ingested foodstuff. Sand and grit are considered to be ten

times more abrasive than phytoliths, so an inclusion of even a small dose of sand or grit in a foodstuff could alter its microwear signature dramatically (Gügel *et al.* 2001).

A likely source of dietary grit in the Belas Knap population is poorly washed saddlequern-milled flour, which, for example is the likely cause of the contrasting microwear between Mesolithic and Neolithic populations at Abu Hureyra in Syria (Molleson, 1994; Molleson and Jones, 1991; see also Teaford and Lytle, 1996). Cereal agriculture may therefore explain the large pits and scratches observed at Belas Knap and hence it should be expected that Aveline's Hole should have smaller microwear features than Neolithic populations. The Tévéc results, which are similar to those of Belas Knap, perhaps corresponds with the marine emphasis in diet (Schulting and Richards, 2001) and resulting sand intake.

Isolating the mechanisms behind dental wear at Aveline's Hole is difficult. It has been surmised that hunting-gathering populations ingest a large quantity of coarse and gritty foods (Smith, 1984). However, Tévéc and Belas Knap show microwear signals dominated by larger features than those that appear at Aveline's Hole. If grit and sand in bread and fish caused the large microwear features at Belas Knap and Tévéc, what caused the microwear features at Aveline's Hole? Grit adhering to dried meat is one candidate, but Ungar and Spencer (1999) have shown that Native North American groups that consume such foods have very large microwear features and extreme dental wear in general, due to the pronounced toughness of the foods concerned and the masticatory force and articulation required to process them. The dried meat hypothesis cannot be completely discounted though, as stable isotope results obtained from the site suggest a high meat dietary protein component (see discussion below). Fresh meat on its own cannot cause dental microwear (tooth-on-tooth attritional wear will cause polishing rather than pits or striations), but even partially dried or smoked meat, or meat butchered in an open environment, may conceivably have incorporated some microwear-causing agents onto its surfaces. However, it is argued here that plant phytoliths are the main agent responsible for the microwear observed at Aveline's Hole. Phytoliths have been shown to cause dental microwear through experimental work (Gügel *et al.*, 2001) and through coprolite analysis (Danielson and Reinhard, 1998). Work with primates has shown that species that feed on leaves and other plant tissues have microwear dominated by thin scratches (Teaford and Walker, 1984). Many wild plants can be eaten, and most plant tissues contain phytoliths; very high attrition rates have been noted in populations dependant on plant taxa which are particularly rich in phytoliths (Danielson and Reinhard, 1998). At present it cannot be said what specific plant foods might be responsible for the wear. Work is underway to attempt to isolate distinctive microwear patterns caused by phytoliths, following the experimental design of Teaford and Lytle (1996). Until these results are known, the conclusion that the observed microwear pattern at Aveline's Hole is largely the result of plant food consumption must be seen as tentative, though it is at present the best hypothesis. This concurs with the molar mesial facet data discussed above, as the mechanism of macrowear would be repeated mastication rather than consuming softer foods loaded with grit.

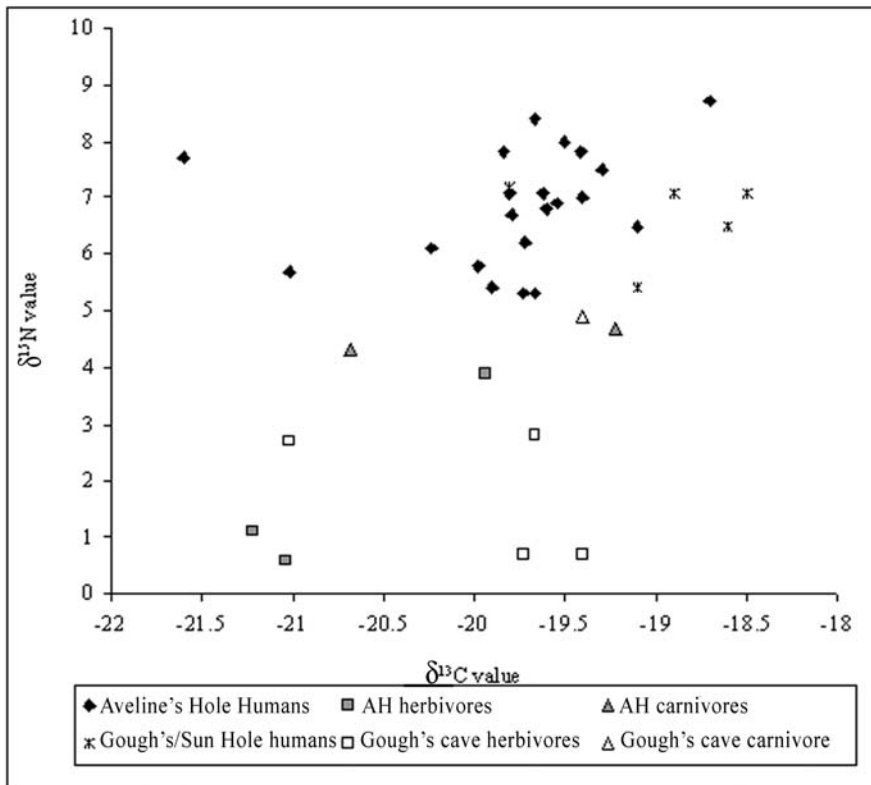
Overall, these results differ from the conventional wisdom that states that hunter-gatherers had a more abrasive and tougher diet than agriculturalists (*e.g.* Chamberlain and Witkin, 2003; Nystrom and Cox, 2003; Smith, 1984:). Dental microwear analysis is a powerful approach to understanding the nature of tooth wear in general (Kieser *et al.*, 2001) and evidence for a softer diet at Aveline's Hole should be factored into age-at-death patterns reconstructed from gross dental macrowear. Microwear data also have the ability to inform debates about changing subsistence in the Mesolithic-Neolithic transition, although until food-specific aetiologies of dental microwear are understood, microwear results are still somewhat ambiguous for these purposes. In the future, better comparative datasets and more control over



parameters such as wear facet selection, enamel structure, SEM technique and also standardisation of microwear recording (*e.g.* Ungar *et al.*, 2003) will improve dental microwear analysis to the point where important, methodologically secure contributions are made to palaeodietary research. Despite limitations in this study, however, the finding that microwear at Aveline's Hole is less extreme than other prehistoric populations is a noteworthy result. The suggestion that the observed microwear is largely the result of plant foods in the diet is also of considerable interest, given the notorious underrepresentation of plant remains (or the assumed lack) on Mesolithic sites across much of northwest Europe. Microwear analysis may thus complement other dietary proxies such as stable isotope analysis that deal with different large food classes over the long term.

### STABLE ISOTOPES AND PALAEODIET (R. Schulting)

Stable carbon and nitrogen isotope ratios preserved in bone collagen can provide important information on certain aspects of past diets. In particular, stable carbon ( $\delta^{13}\text{C}$ ) measurements reflect the consumption of marine versus terrestrial protein, while stable nitrogen ( $\delta^{15}\text{N}$ ) measurements reflect an organism's trophic level (its position in the food web) (Chisholm *et al.*, 1982; DeNiro and Epstein 1981; Schwarz 1991).



**Figure 30.** Plot of stable carbon and nitrogen isotope results on human and faunal bone collagen (Gough's Cave data from Richards *et al.*, 2000).

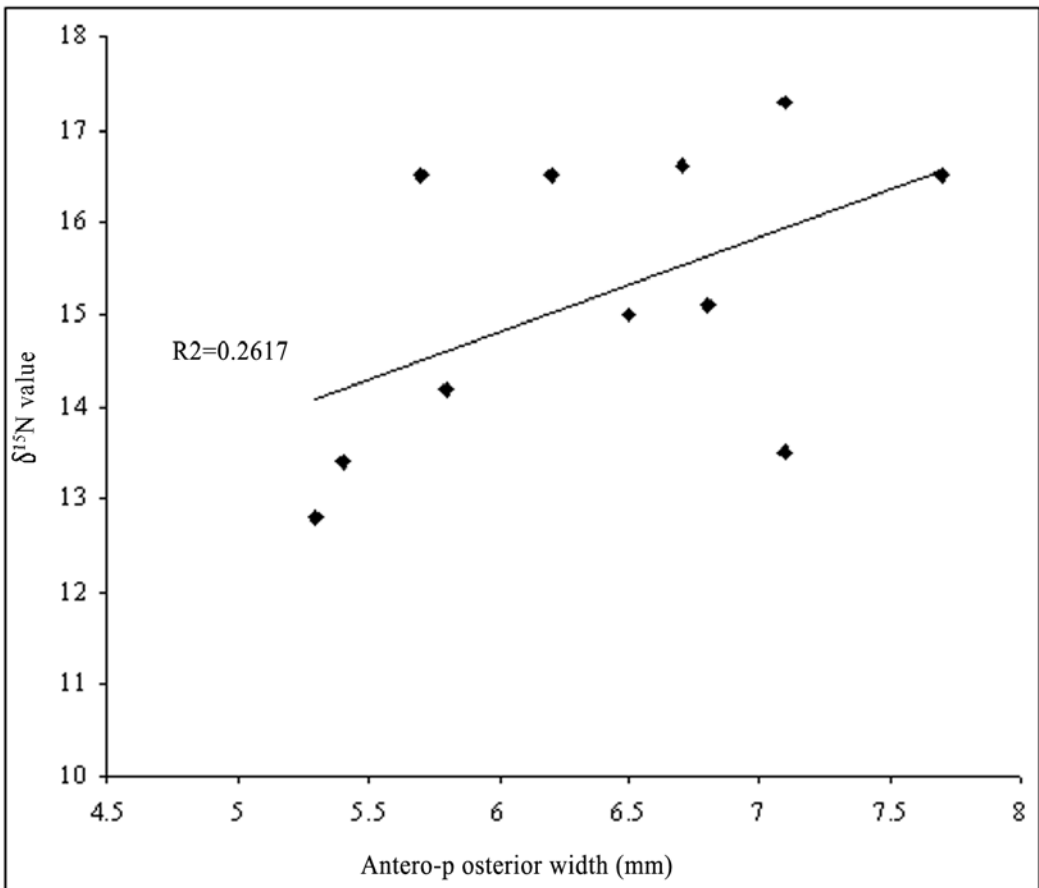
The previously available stable isotope measurements obtained on human bone collagen (Schulting and Richards, 2000; Schulting and Wysocki, 2002) can now be greatly expanded through the inclusion of 18 new measurements, obtained through the Centre for Isotope Research, University of Groningen (Table 11; Figure 30). C:N ratios serve as one means of assessing the quality of the extracted collagen, and the values obtained here are all within the accepted range of 2.9-3.6 (DeNiro 1986). The  $\delta^{13}\text{C}$  values group very closely, ranging from  $-19.1$  to  $-21.6\text{‰}$ , averaging  $-19.9 \pm 0.6\text{‰}$ . The  $\delta^{15}\text{N}$  values are somewhat more dispersed, ranging from  $5.3$  to  $8.4\text{‰}$ , averaging  $6.6 \pm 0.9\text{‰}$ . These values are broadly comparable with those for three individuals previously reported, although these did tend to show slightly more elevated values for both isotopes (the small difference is likely due primarily to inter-laboratory variability). As a different element (ulnae) was sampled for the new series, it is possible that some or all of the three individuals previously measured are repeated. It is clear that, even with the greatly expanded dataset, no individuals show any significant contribution of marine protein. This includes an absence of evidence for the use of salmon, which show a predominantly marine isotopic signature. While some individuals exhibit slightly elevated  $\delta^{13}\text{C}$  values, the complete lack of any correlation with higher  $\delta^{15}\text{N}$  values ( $r^2 = 0.001$ ) strongly militates against the possibility of even a small contribution of marine protein, which would result in noticeably higher  $\delta^{15}\text{N}$ , and should lead to a positive correlation between  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values. Similarly, any substantial use of freshwater fish should result in more elevated  $\delta^{15}\text{N}$  values (Dufour *et al.*, 1999; Katzenberg and Weber, 1999; Lillie and Richards, 2000). It is more likely that the slightly elevated  $\delta^{13}\text{C}$  values can be traced to terrestrial prey also showing similarly elevated values, a phenomenon that has been observed elsewhere for a number of late Pleistocene and early Holocene species (Drucker *et al.*, 2003; Iacumin *et al.*, 1997; Richards and Hedges, 2003).

<i>Catalogue no.</i>	<i>Element</i>	<i>species</i>	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$
temp V-1	tibia shaft	<i>Vulpes</i> sp.	-19.2	4.7
temp L-1	radius	<i>Lynx lynx</i>	-20.7	4.3
temp C-1	metatarsal	<i>C. elaphus</i>	-19.9	3.9
temp C-2	metatarsal	<i>C. elaphus</i>	-21.0	0.6
temp U-1	humerus	large ungulate	-21.2	1.1

**Table 9.** *Stable carbon and nitrogen isotope measurements on animal bone collagen from Aveline's Hole.*

Unfortunately there are only limited faunal remains surviving from Aveline's Hole (see Murray and Schulting below), less in fact than the human remains. Yet we know that a substantial faunal assemblage was once present (Davies, 1921, 1923; Skinner, 1819). This has resulted in very limited comparative isotopic data, consisting of a lynx (*Lynx lynx*), a canid (probably fox, *Vulpes vulpes*), two red deer (*Cervus elaphus*) and an unidentified large ungulate (an additional small collection of fauna at the Natural History Museum, London, was not included in this sampling exercise). The  $\delta^{13}\text{C}$  values are as expected for terrestrial mammals, averaging  $-20.4 \pm 0.8\text{‰}$  (Table 9). What is more surprising is the consistently low  $\delta^{15}\text{N}$  values, ranging from *c.*  $4.5\text{‰}$  for the two carnivores to only  $0.6\text{‰}$  to  $3.9\text{‰}$  for the three herbivores.

This helps put the average human  $\delta^{15}\text{N}$  value of 6.6‰ into perspective. In later prehistory (e.g., the Neolithic period from c. 4000 cal BC), such a value would be considered very low and would suggest an important contribution from plant protein in the diet (Richards, 2000). But faunal  $\delta^{15}\text{N}$  values in the Neolithic are also significantly higher than those more typically seen in the Late Glacial and early Holocene (Drucker *et al.*, 2003; Iacumin *et al.*, 1997; Richards, 2000; Richards and Hedges, 2003). Thus we should most plausibly interpret the Aveline's Hole  $\delta^{15}\text{N}$  values as indicating a high component of animal protein in the diet. This is in accord with the interpretation placed upon Late Upper Palaeolithic (c. 12000 BP) humans from Sun Hole Cave and Gough's Cave, with broadly comparable  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values for both humans and fauna (Figure 30) (Richards *et al.*, 2000). It must be remembered, however, that stable isotope measurements on bone collagen reflect only the protein component of the diet, and that most plant foods are much lower in protein than animal products. There are certain exceptions, of which hazelnuts would figure most prominently for the Mesolithic period, at least in terms of their ubiquity on sites of the period (Zvelebil, 1994).



**Figure 31.** Plot of stable nitrogen isotopes (a measure of the degree of animal protein consumption) and antero-posterior width (taken below radial notch of proximal left ulnae) from Aveline's Hole. Only a slight positive correlation with size can be seen.

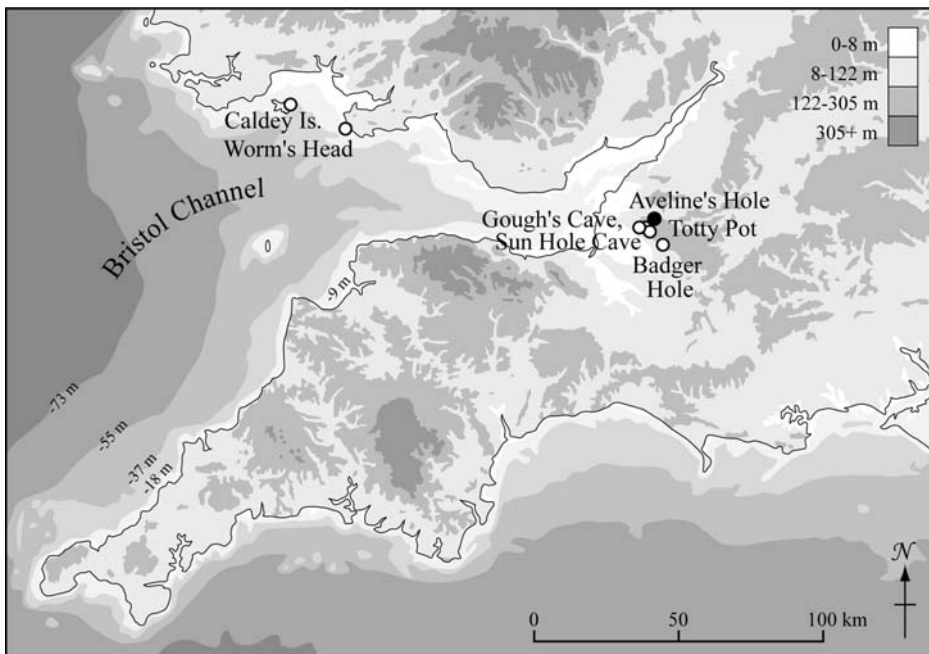
The observed range of human  $\delta^{15}\text{N}$  values, from 5.3 to 8.4‰, taken at face value, does appear to indicate a considerable degree of variation in the contribution of animal protein in the diet, with some individuals consuming a greater proportion of plant-derived protein. Or, put another way, there may have been differential access to animal protein. But the results still have to be viewed in the context of the low values of *c.* 4.5‰ for the two non-human carnivores (though the fox might be better seen as an omnivore). The comparison is not necessarily a straightforward one, however, as the degree of trophic enrichment may be in part dependent on taxon (DeNiro and Epstein, 1981; Minagawa and Wada, 1984; Vanderklift and Ponsard, 2003). While a  $\delta^{15}\text{N}$  enrichment of 3‰ is often used, Bocherens and Drucker (2003) have recommended using a range of values, from 3–5‰. More importantly, the range of variation in the  $\delta^{15}\text{N}$  values of the prey species could itself easily account for the observed differences in the humans (see Figure 30). Thus, the preferential consumption (for whatever reason) of certain prey species by some individuals could have the same effect on their stable nitrogen isotopes as the consumption of greater quantities of plant protein.

An attempt was made to investigate the possibility that sex played a role in the amount or kind of animal protein consumed. Though it is not possible to accurately sex the incomplete ulnae sampled for dating and isotope analysis, twelve of the more complete proximal shaft fragments were ranked by general size and robusticity to determine whether any trend could be observed in relation to  $\delta^{15}\text{N}$  values (e.g., Figure 21). This exercise results in an average  $\delta^{15}\text{N}$  value of 6.7‰ for the five largest elements, compared with 5.9‰ for the four smallest elements, and 6.3‰ for three intermediate ulnae. While perhaps suggestive, the difference between the putative ‘males’ and ‘females’ does not approach statistical significance ( $t = 1.22$ ,  $p = 0.27$ ) due to considerable variability within the two groups. An  $r^2$  value of 0.26 shows only a weak positive correlation between antero-posterior diameter of the proximal ulna shaft and  $\delta^{15}\text{N}$  value (Figure 31). The analysis may also be partly confounded by the inclusion of possible adolescents amongst the smaller elements (confirmation is not possible due to the absence or erosion of many of the epiphyses).

The dental microwear results (see McLaughlin, above) have been provisionally interpreted as indicating relatively high plant food consumption. This presents something of a contradiction with the stable isotope results as reported here. However, it is important to remember that the two dietary proxies refer to very different time-scales, the stable isotopes reflecting averaged diet over some 10 years, and microwear reflecting foods eaten over the last week or so. Nevertheless the consistency between the admittedly limited number of individuals analysed for microwear still suggests that this may not suffice as the entire explanation. Another possibility is that, just as stable isotope analysis on bone collagen is biased towards high protein (*i.e.*, animal) foods (Ambrose and Norr, 1993), dental microwear may be biased towards plant foods due to the presence of phytoliths and adhering grit. Thus, it may be that even in a high meat diet, and depending on the methods of preparation and preservation, if any, dental microwear tends to emphasise the consumption of plant foods. Further research is being undertaken on this issue, using experimental microwear studies.

The absence of any evidence for the use of marine foods is not necessarily surprising given the distance, some 80 km or more, of the site from its contemporary coastline (Figure 32; see discussion below). Nevertheless, this finding is of considerable interest, in that hunter-gatherers in temperate forest environments are typically mobile over a very large area. This is particularly so for the early Holocene, when population densities are expected to have been quite low. Estimates on the order of 0.01–0.02 persons/km<sup>2</sup> have been suggested for the British Mesolithic, though this figure may have been locally higher in favourable locations (Smith,

1992a). This seems unduly low, with Jochim (1979) suggesting considerably higher figures of 0.11 to 0.26 persons/km<sup>2</sup> for the Mesolithic of southwest Germany. Constandse-Westermann and Newell (1989) suggest an average population density of 0.1 persons/km<sup>2</sup> for the European Mesolithic in general. For the Boreal period of northern France, which should be roughly comparable to the situation in southern Britain, Rozoy (1998) suggests the presence of a number of 'tribal territories', each on the order of 15,000 km<sup>2</sup>. Transposing this figure to Aveline's Hole, the coast could just have been encompassed within such a territory, which would have had a radius of nearly 70 km. The perforated periwinkle shell beads in the cave indicate coastal connections, assuming these were associated with the burials, as seems reasonable. Similarly, the pebble flint may have been collected from the beach, though it could also have come from a stream (Jacobi, this volume; *pers. comm.*). That the stable isotope data show no convincing evidence for the use of marine protein, then, suggests that either 1) the territory of the group using the cave for burial did indeed extend to the coastline, but that marine resources were not exploited to any significant extent, or 2) the territory did not extend to the coast, but was focused instead entirely on an inland strategy. This raises the question of the possible presence of other communities that *were* more focused on the coast and on marine resources, which would indicate a degree of subsistence specialisation perhaps unexpected at this early period, and could suggest higher population densities than are typically entertained. Certainly by only a few centuries later at Caldey Island, south Wales, marine foods have been shown to have played a very important role in the diet, suggesting an emphasis on coastal settlement and resources (Schulting and Richards, 2002) (Figure 32).



**Figure 32.** Map of the Bristol Channel area showing locations of sites mentioned in text, together with submarine contours and inferred sea levels. Sea-level at c. 8300 cal BC can be placed at approximately the -37m contour (Allen, 2001; Hawkins, 1971; Heyworth and Kidson, 1982).

## STRONTIUM ISOTOPES AND MOBILITY (T.D. Price and R. Schulting)

A further attempt to deal with the issue of the scale of mobility of the Aveline's Hole burial population was made using strontium isotope analysis. This was undertaken to investigate the possibility that individuals not local to the area could be identified. In part this follows from a suggestion made by Smith (1992a, 1992b, p. 171), involving the site's use as a central burial place for a population from the wider region around the Mendips.

Isotopic provenancing of human remains has become a reliable means of distinguishing local and 'foreign' individuals in a burial population (e.g., Budd *et al.*, 2003; Montgomery *et al.*, 2000; Price *et al.*, 1994, 2001, 2004). Strontium isotope ratios reflect the bioavailable strontium from the geology of the area where an individual was living during the period the tooth formed. The enamel of the first molars selected here for analysis forms during early childhood, between the first and fourth years of life (Ubelaker, 1978) and remains unchanged thereafter. Enamel is also the hardest tissue in the skeleton and the most resistant to contamination; it appears to be very stable in the burial environment, and is far less subject to diagenesis than other skeletal tissues (bone or dentine) (Budd *et al.*, 2003). Thus, if the values obtained on prehistoric human teeth do not reflect the geology of the area in which they were found, it can be inferred that they are not 'native' to that area. Strontium isotopes are normally measured on a Thermal Isotope Mass Spectrometer (TIMS) and reported as a ratio of  $^{87}\text{Sr}$  to  $^{86}\text{Sr}$ .  $^{87}\text{Sr}$  is about 7% in nature while  $^{86}\text{Sr}$  is about 10%. Known ratios in human populations from various parts of the world range from approximately 0.703 to 0.730. These values are readily distinguishable using the TIMS instrument. Strontium isotope values for the older rock of the Mendips are expected to be around 0.7100, while those for the Cretaceous Chalk of the Downs to the east are expected to fall around 0.7075, with an upper limit of 0.708 (Budd *et al.*, 2003; Montgomery *et al.*, 2000).

Strontium isotope measurements were obtained on enamel from eight human and two faunal teeth (a cervid and a bovid) from Aveline's Hole and are presented in Table 10. Five of the human teeth are maxillary left first molars, and so a minimum of five distinct individuals must be represented. The values for the human samples range from 0.7091 to 0.7101 with a mean of  $0.7098 \pm 0.0003$ . The values are consistent and, with one exception, show little variation. The two faunal samples are somewhat higher than the human samples with an average of  $0.7104 \pm 0.0005$  and likely reflect the local isotopic signature, *i.e.*, the bioavailable ratio, around Aveline's Hole. Thus the human values, being significantly lower ( $t = 2.31$ ,  $p = .049$ ), indicate either movement of the group to a different area during some time of the year or hunting/collecting activities that return foods from isotopically distinct locales back to the region of Aveline's Hole. This is particularly so for the exception referred to above, a human tooth (M1.11.175) exhibiting a strontium isotope ratio more than two standard deviations below the human mean.

The results, while limited by the small sample size, are intriguing. The average human value is quite close to, but slightly lower than, what might be expected for a Mendip signal (Table 10; Figure 33). Thus there is some slight hint that communities were ranging further afield than the Mendips alone. This is emphasised by the small but significant difference between the human and the faunal samples, which are assumed to present a more immediately local Mendip signal (though of course this also depends on the mobility and range of these species). It should be noted that the observed human values are also consistent with the strontium isotope ratio of the Holocene sea itself, about 0.7092 (Hess *et al.*, 1986). However, the possibility that the population using Aveline's Hole was exploiting marine foods is not

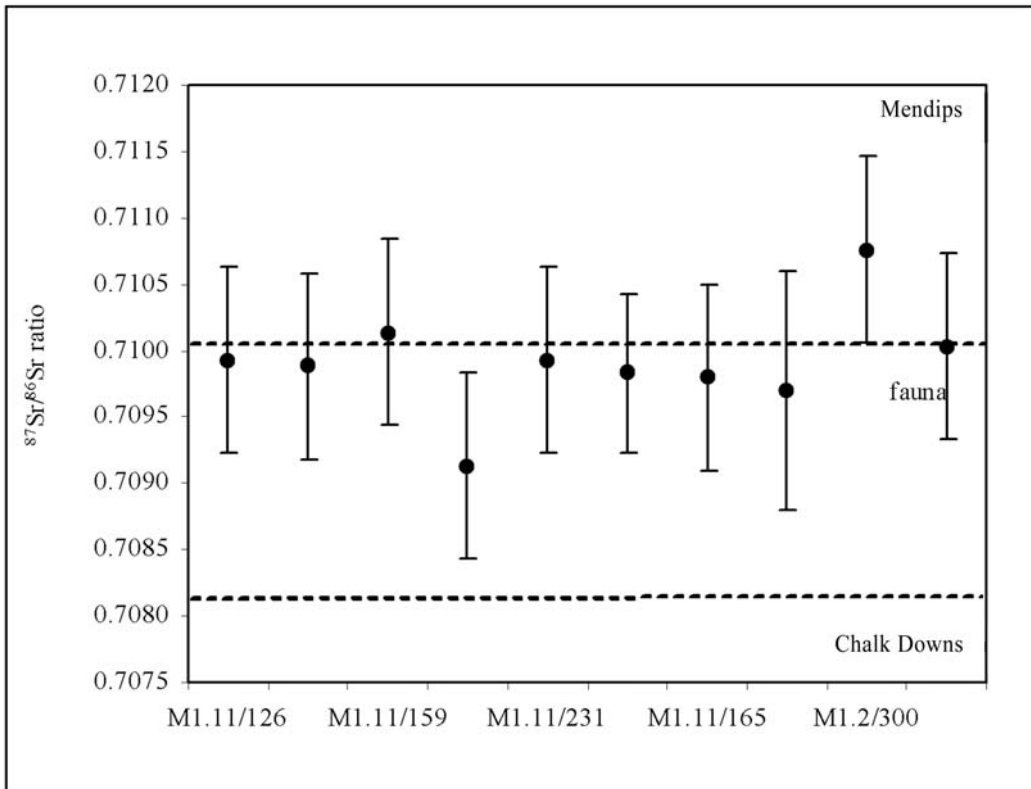
supported by the stable carbon and nitrogen isotope evidence, leaving some, if relatively minor, input from the western Chalk Downs as the more likely candidate for the observed strontium values. The individual represented by tooth M1.11.175 may conceivably have spent more time during early childhood in an area closer to the Chalk than did the other individuals.

The western edge of the Chalk is about 50 km east of Burrington, though less than half this distance from the eastern end of the Mendips. Thus the distances involved are not great. In this sense, it is perhaps surprising that the human strontium isotope values indicate as little input from the Chalk as they seem to do. Other lines of evidence at Aveline's Hole do suggest at least occasional journeys in this direction, though they may relate more directly to the Creswellian use of the cave than to the Early Mesolithic. The nearest source for a fossil shell of *Pseudomelania heddingtonsensis* (a species of the Upper Jurassic Coralian) found encased in stalagmite in the cave is reportedly near either Trowbridge, Wiltshire or Wincanton, Somerset, both of which lie some 40 km east of Burrington, near the western edge of the Chalk (Davies, 1923, Plate I.2; Donovan 1968). Interestingly, Trowbridge is also noted as the nearest source of natural flint to Burrington (Davies, 1923, p. 10). The flaked stone tool assemblage is, with one possible exception, comprised entirely of flint, and includes both chalky and pebbled skins (Jacobi, this volume). The former most likely derives from the Chalk (as has also been noted for the Late Upper Palaeolithic assemblage from Gough's Cave, Jacobi, 2004), while the latter could have come from a stream or from the coast, which at the time would have been at a considerably greater distance than the Chalk. While again much (though not all) of the Aveline's Hole assemblage may be Creswellian, Early Mesolithic use of Chalk flint is seen on sites some 25 km further south (Bond, 2004; Norman, 1982; Wainwright, 1960), so it is clear that people were either themselves making the journey to the east at this time, or were in contact with communities there through exchange. Movement of high quality flint from the chalklands to the Mendip area continues through later prehistory as well (Bond, 2004; Grinsell, 1985).

<i>Species</i>	<i>Cat No.</i>	<i>Element</i>	$^{87}\text{Sr}/^{86}\text{Sr}$ ratio	<i>SD</i>	+2 <i>sd</i>	-2 <i>sd</i>
human	M1.11/126	max. LM1	0.709925	0.0007	0.711325	0.708525
human	M1.11/149	max. LM1	0.709886	0.0007	0.711286	0.708486
human	M1.11/159	max. LM1	0.710139	0.0007	0.711539	0.708739
human	M1.11/175	max. LM1	0.709132	0.0007	0.710532	0.707732
human	M1.11/231	max. LM1	0.709928	0.0007	0.711328	0.708528
human	M1.11/95	mand. M1/2	0.709833	0.0006	0.711033	0.708633
human	M1.11/165	mand. M1/2	0.709798	0.0007	0.711198	0.708398
human	M1.11/172	molar	0.709692	0.0009	0.711492	0.707892
cervid	M1.2/300	max. molar	0.710757	0.0007	0.712157	0.709357
bovid	M1.2/301	mand. molar	0.710035	0.0007	0.711435	0.708635

**Table 10.** *Strontium isotope measurements on human and faunal teeth from Aveline's Hole.*

One possible reason for only tenuous strontium isotope evidence for movement away from the Mendips may be the young age represented by the sampled first molars (1-4 years). Conceivably travels to the east to directly acquire or trade for flint were undertaken by special task groups and did not involve the entire community, especially not small children. Analysis of the third molar, formed during later childhood (ages 9-12), could prove interesting. Further understanding of local variability in strontium isotope ratios for the complex geology of the Mendips and surrounding area will be needed to fine-tune the interpretation. Lead isotope analysis should provide some further refinement of this picture, and is currently underway, though unfortunately the results are not yet available.



**Figure 33.** Graph of  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope ratios for Aveline's Hole (Mendip and Chalk Down values are from Montgomery *et al.*, 2000).

## DATING

(P.D. Marshall and J. van der Plicht)

Eighteen samples were submitted to the Centre for Isotope Research of the University of Groningen, The Netherlands, for Accelerator Mass Spectrometry (AMS) radiocarbon dating in 2003. The samples, all human bone, were processed according to the procedures set out in Aerts-Bijma *et al.* (1997, 2001) and van der Plicht *et al.* (2000).



Laboratory Code	UBSS cat. no.	Element	$^{14}\text{C}$ years BP	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$	C:N	Cal BC date (95% confidence)	Posterior Density Estimate
GrA-22607	M1.11/307	cranium	9180±50	-19.4	7.0	3.1	8550–8270	8410-8260
GrA-22421	M1.13/38	left ulna	8890±45	-19.7	5.3	2.9	8240–7830	8270-8170
GrA-22552	M1.13/118	left ulna	9200±50	-19.7	5.3	2.9	8560–8280	8410-8270
GrA-22605	M1.13/144	left ulna	8980±50	-21.0	5.7	3.5	8280–7960	8290-8190
GrA-22422	M1.13/152	left ulna	9095±45	-19.6	6.8	2.9	8430	8410-8390 (2%) 8360-8230 (93%)
GrA-22428	M1.13/154	left ulna	9075±45	-19.6	7.1	3.1	8410–8230	8340-8220
GrA-22555	M1.13/159	left ulna	9020±50	-19.9	5.4	3.0	8290–7970	8290-8200
GrA-22429	M1.13/160	left ulna	9100±45	-19.8	7.1	3.2	8450–8240	8410-8230
GrA-22431	M1.13/161	left ulna	8925±45	-19.4	7.8	2.9	8260–7940	8270-8170
GrA-22432	M1.13/163	left ulna	9155±45	-19.8	6.7	3.2	8530–8260	8410-8260
GrA-22433	M1.13/164	left ulna	9090±45	-19.1	6.5	3.2	8430–8230	8410-8390 (1%) 8360-8230 (94%)
GrA-22546	M1.13/166	left ulna	9060±50	-21.6	7.7	3.8	8410–8210	8330-8200
GrA-22557	M1.13/172	left ulna	9120±50	-20.0	5.8	2.9	8460–8240	8410-8230
GrA-22547	M1.13/300	left ulna	9170±50	-20.2	6.1	3.0	8540–8260	8410-8260
GrA-22548	M1.13/301	left ulna	9170±50	-19.8	7.8	3.2	8540–8260	8410-8260
GrA-22621	M1.13/302	left ulna	9130±60	-19.7	6.2	3.3	8530–8240	8410-8270
GrA-22938	M1.13/329	left ulna	8960±50	-19.7	8.4	3.1	8270–7960	8280-8180
GrA-22558	M1.14/99	left ulna	9210±70	-19.6	6.9	3.4	8630–8270	8420-8260
				Average	-19.9	6.6		
				SD	0.6	0.9		

**Table 11.** *Aveline's Hole radiocarbon results.*

The radiocarbon determinations in Table 11 have been calibrated with data from Stuiver *et al.* (1998), using OxCal v3.5 (Bronk Ramsey, 1995, 1998). The date ranges have been calculated according to the maximum intercept method (Stuiver and Reimer, 1986), and are cited at two sigma (95% confidence). They are quoted in the form recommended by Mook (1986), with the end points rounded outwards to 10 years. The probability distributions (Figure 34) are derived from the usual probability method (Stuiver and Reimer, 1993).

### *Analysis and Interpretation*

The calibrated dates given in Table 11 (and probability distributions shown in Figure 34) are accurate estimates of the dates of the samples, however, in archaeological terms they are not exactly what we want to know. Of much greater interest and potential importance are the dates of the archaeological events represented by those samples. Absolute dating information in the form of radiocarbon measurements on the skeletons can be combined with the relative information provided by stratigraphic relationships between samples to provide estimates of the dates of the burial activity.

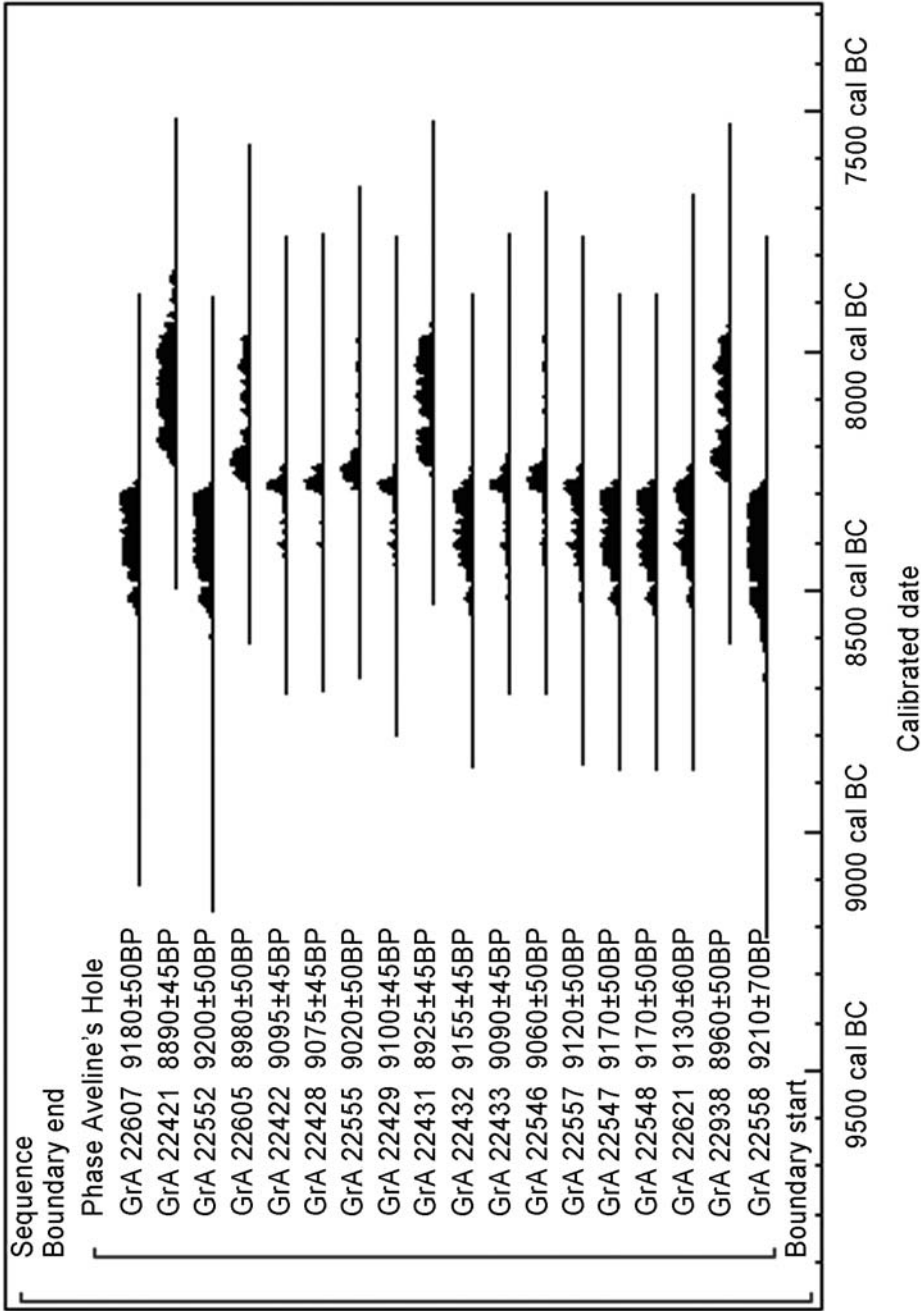
These posterior density estimates are not absolute, they are interpretative estimates, that can and will change as further data becomes available and as other people choose to model the existing results from different perspectives.

The methodology used to combine these different sorts of information is a form of Markov Chain Monte Carlo sampling, and has been applied using the program OxCal v3.5 <http://www.rlaha.ox.ac.uk/orau/oxcal>, which uses a mixture of the Metropolis-Hastings algorithm and Gibbs sampler (Gilks *et al.*, 1996; Gefland and Smith, 1990). Details about the algorithms used by OxCal can be accessed from the on-line manual or in Bronk Ramsey (1995, 1998). The specific algorithms used in the models described below can be derived from the structures in Figure 35, or from the chronological query language files which are contained in the project archive.

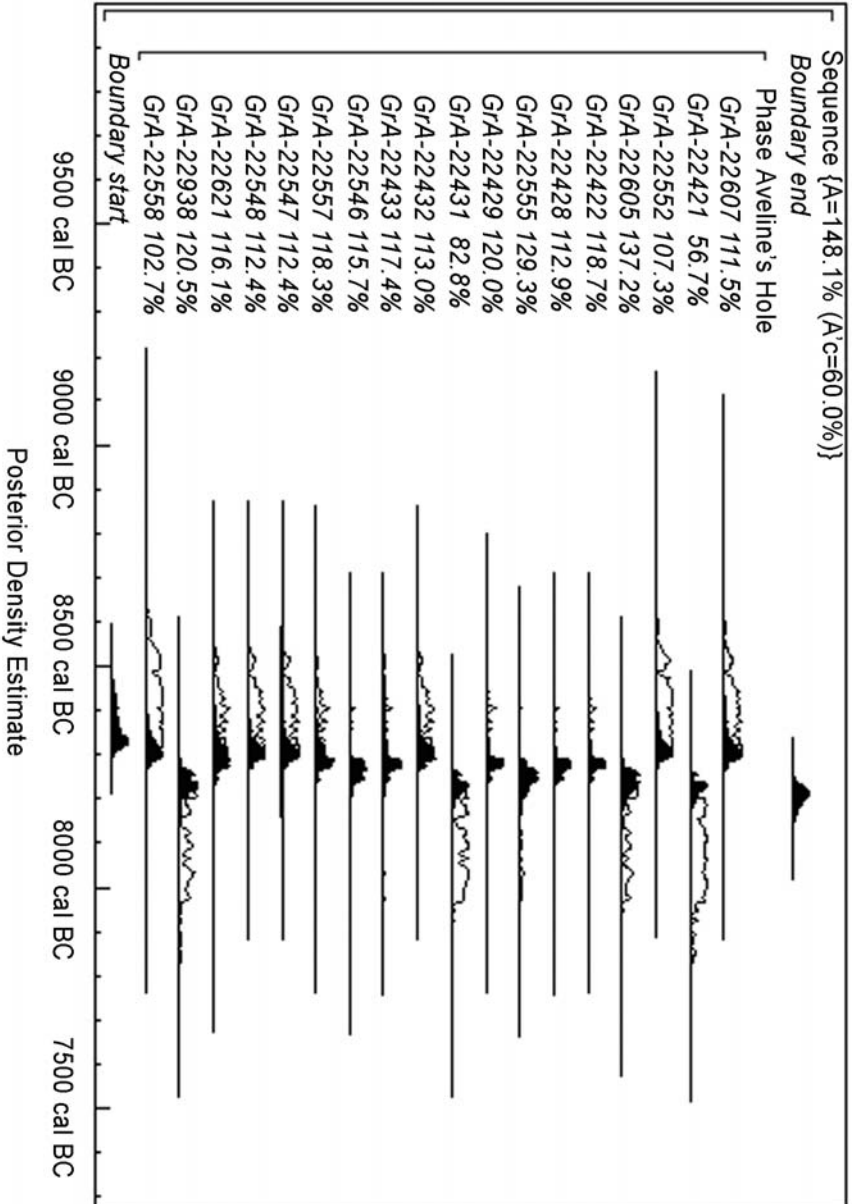
The only assumption incorporated in the model for Aveline's Hole is that of a uniform rate of burial within the cemetery during its period of use (Buck *et al.*, 1992; Gefland and Smith, 1990). The high overall index of agreement ( $A_{\text{overall}} = 148.1\%$ ) indicates that the radiocarbon results are in good agreement with this hypothesis. The model provides estimates for the start of activity of 8460-8290 cal BC (95% probability) and the end of burial activity of 8260-8140 cal BC (95% probability). Figure 36 shows the estimated length of the phase of burial activity to be between 70-180 years (68% probability).

In addition to the eighteen radiocarbon measurements obtained in 2003, five measurements were previously obtained on human remains from Aveline's Hole from the Oxford Radiocarbon Accelerator Unit, the British Museum and the Godwin Laboratory, Cambridge. These measurements calibrated using the maximum intercept method (Stuiver and Reimer, 1986) are shown in Table 12, together with determinations on human bone from three other Mendip Mesolithic sites.

If these five results are included in the model as previously outlined, the overall index of agreement ( $A_{\text{overall}} = 127.5\%$ ) shows good agreement with the hypothesis that all the dated skeletons belong to a single phase of burial activity (see Figure 37). However, the individual index of agreement for OxA-1070 is rather low ( $A = 26.9\%$ ). A value of less than 60% generally indicates a high likelihood (> 95%) that there is a problem with a sample (Bronk Ramsey 1995). Thus if OxA-1070 is excluded from the analysis, the overall index of agreement increases ( $A_{\text{overall}} = 161.2\%$ ), and the probability that OxA-1070 belongs to this phase of activity is very low ( $A = 1.7\%$ ) (Figure 38). This contrasts with the only slight older determination for OxA-800, which nevertheless fits in far better with the postulated main phase ( $A = 65.8\%$ ).



**Figure 34.** Probability distributions of new dates from Aveline's Hole. Each distribution represents the relative probability that an event occurred at a particular time. These distributions are the result of simple radiocarbon calibration (Stuiver and Reimer, 1993).

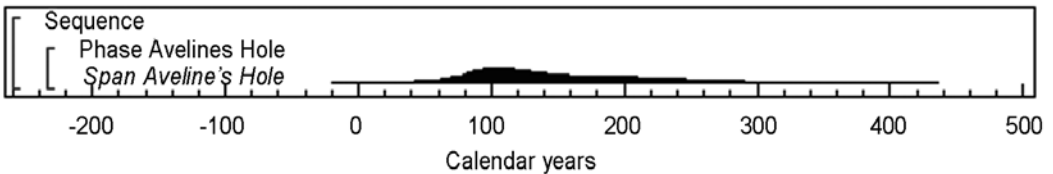


**Figure 35.** Probability distributions of new dates from Aveline's Hole: each distribution represents the relative probability that an event occurs at a particular time. For each of the radiocarbon dates two distributions have been plotted, one in outline, which is the result of simple radiocarbon calibration, and a solid one, which is based on the chronological model used. The large square brackets down the left hand side along with the OxCal keywords define the model exactly.

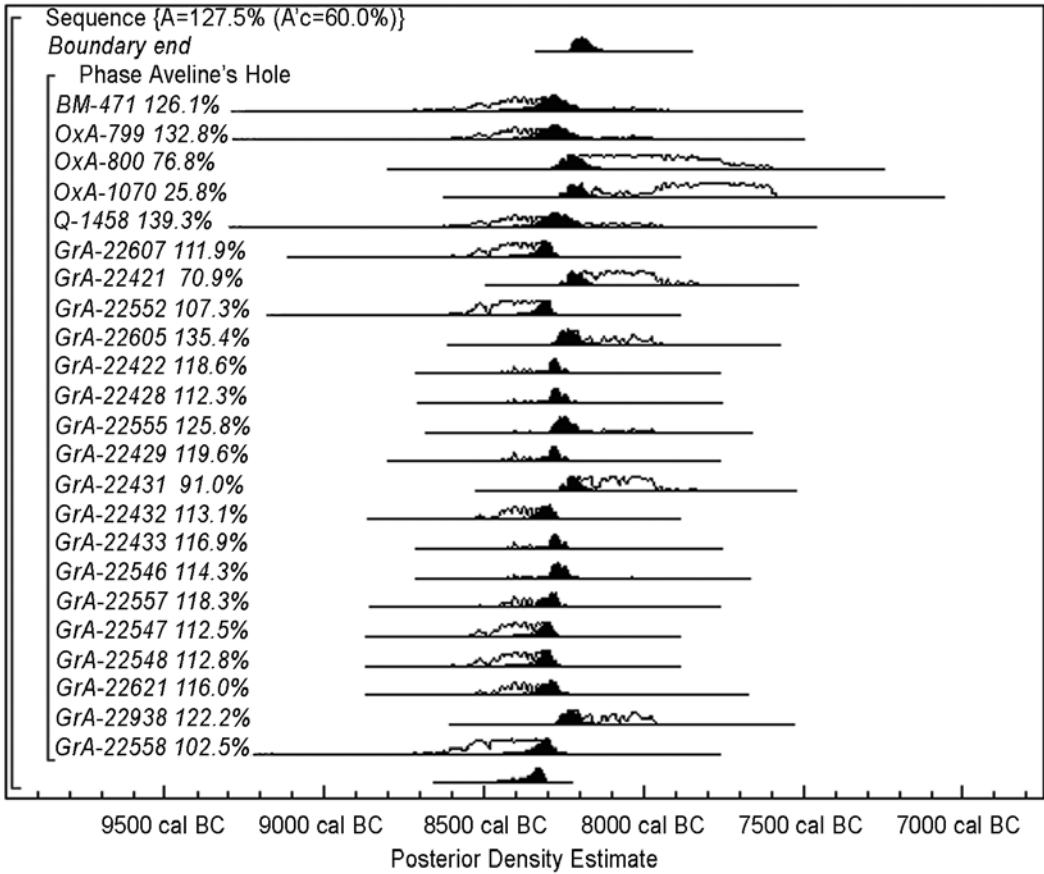
Therefore, OxA-1070 could be a statistical outlier, although the possibility that this individual was a slightly more recent burial cannot be ruled out.

Laboratory Code	Specimen	Element	$^{14}\text{C}$ years BP	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$	Calibrated date (95%)
<i>Aveline's Hole</i>						
OxA-799	M1.13/23	right humerus	9100±100	-19.3	7.5	8560-7970 cal BC
OxA-800	M1.13/24	right humerus	8860±100	-19.5	8.0	8270-7600 cal BC
OxA-1070	M1.13/146	right humerus	8740±100	-18.7	8.7	8210-7580 cal BC
BM-471	M1.14/136	femur	9115±110	-	-	8630-7970 cal BC
Q-1458		post-cranial frags.	9090±110	-	-	8560-7960 cal BC
<i>Gough's Cave ('Cheddar Man')</i>						
OxA-814	1.1/29	talus	9100±100	-	-	8610-7980 cal BC
BM-525		tibia	9080±150	-	-	8700-7760 cal BC
<i>Badger Hole</i>						
OxA-1459	BH2	mandible	9360±100	-	-	9120-8300 cal BC
OxA-679	BH1	cranial fragments	9060±130	-	-	8610-7830 cal BC
<i>Totty Pot</i>						
BM-2973		left humerus	8180±70	-19.4	-	7450-7050 cal BC

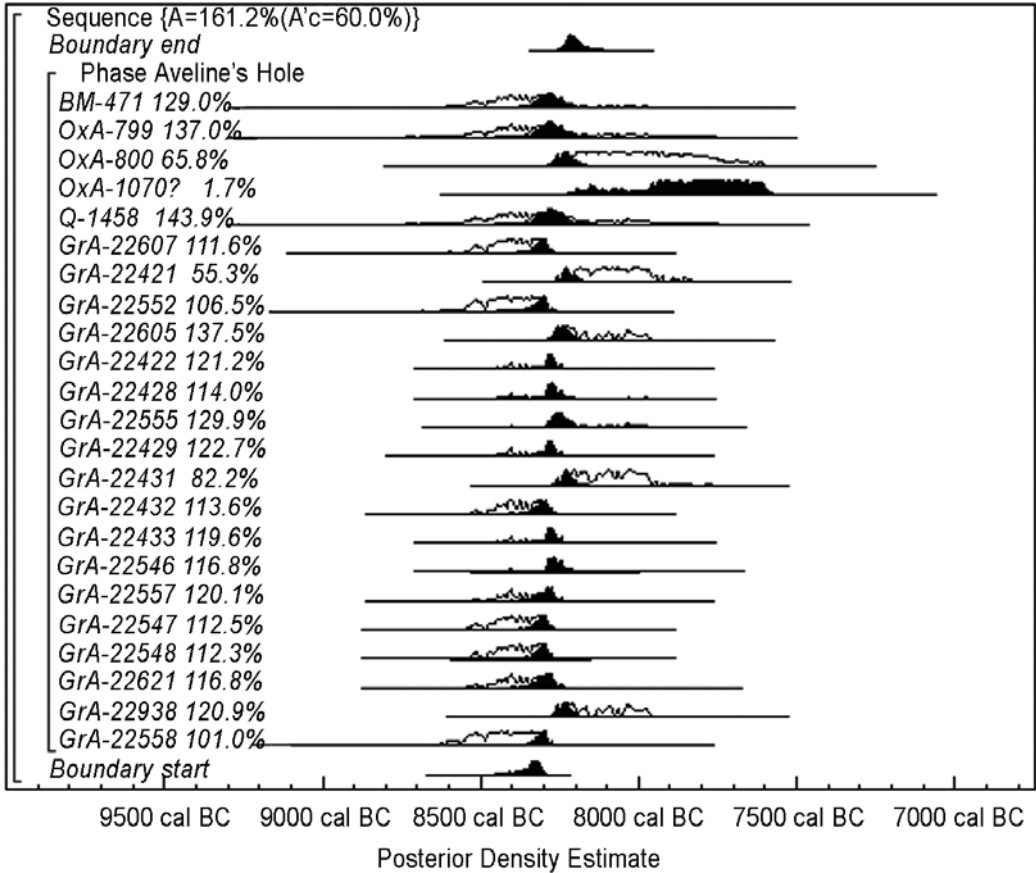
**Table 12.** Previous radiocarbon results on human bone from Aveline's Hole, together with results on human bone from three other Mendip sites. Sources in text.



**Figure 36.** Probability distribution of the number of years during which Aveline's Hole was in use ('Span Aveline's Hole') derived from the model defined in Figure 35.



**Figure 37.** Probability distributions of all dates from Aveline's Hole: each distribution represents the relative probability that an event occurs at a particular time. For each of the radiocarbon dates two distributions have been plotted, one in outline, which is the result of simple radiocarbon calibration, and a solid one, which is based on the chronological model used. The large square brackets down the left hand side along with the OxCal keywords define the model exactly.



**Figure 38.** Probability distributions of all dates from Aveline's Hole (OxA-1070 excluded from the analysis): each distribution represents the relative probability that an event occurs at a particular time. For each of the radiocarbon dates two distributions have been plotted, one in outline, which is the result of simple radiocarbon calibration, and a solid one, which is based on the chronological model used. The large square brackets down the left hand side along with the OxCal keywords define the model exactly.

## FAUNAL REMAINS (E. Murray and R. Schulting)

A small collection of animal bones survive from the early twentieth century excavations carried out by the University of Bristol Spelaeological Society at Aveline's Hole. In the original reports the large mammal remains were identified by Davies (1921, 1922, 1923, 1925), the diverse bird and small mammal remains (voles, bats etc.) by Newton (1921, 1922, 1925) and Hinton (1921, 1923) respectively and the molluscs by Kennard and Woodward (1923): between them they amassed a total of 116 species identifications (Davies, 1923, p. 11). Unfortunately, the majority of this material was destroyed during a World War II bombing raid on Bristol but a small collection of around a hundred specimens (half of which are identifiable) survives in the UBSS Museum, along with a slightly larger assemblage in the Natural History Museum in London. An account of the two collections is presented below followed by a brief discussion.

### *Methodology*

The bones from the UBSS collection curated in Bristol were identified using comparative collections held in the Ulster Museum, Belfast and the Natural History Museum (NHM), London in April 2003. The London assemblage (also comprising material from the UBSS excavations, but referred to hereafter simply as the NHM assemblage, with UBSS reserved for the Bristol collection) was examined in the NHM in July 2005 using the palaeontology collections as reference material. Over half of the specimens stored in London consist of the micro-fauna (voles etc.) identified by Hinton. In Hinton's original reports (1921, 1923) this material was not quantified so it is uncertain what proportion of the original assemblage this represents. This material was not re-examined but the few surviving rodent bones in the UBSS collection were recorded.

All identifiable fragments were counted and the number of elements identified to species for the combined collection is presented in Table 13. Catalogue numbers (e.g. M1.21.33) accompanied most of the Bristol specimens while about two thirds of the NHM bones were labelled and ascribed to either the first or third foot (curiously, no material from the second foot was present, though this spit was noted in the reports as also containing abundant 'giant red deer', reindeer, badger, brown bear, fox and other fauna; Davies, 1921, p. 61). Specific details of the zones represented, metrical and fusion data and contextual details, where known, were recorded and a catalogue of this data for the two collections has been deposited with the UBSS. In addition to the identified specimens there were also a number of ribs, vertebrae and long bone fragments that could not be positively identified and which were simply assigned to large (e.g. cattle, red deer etc.) or medium-sized (pig, sheep etc.) mammals. These are also recorded in the catalogue.

### *Species identified*

The species identified comprise much the same range in both collections, namely domestic cattle, pig and sheep, red deer, reindeer, lynx, red fox, dog/wolf, hare and bird. In addition, the NHM assemblage also had bones of rabbit, arctic fox, wild cat, badger and horse (Table 13) while a fish vertebrae (not identified to species) was noted in the UBSS assemblage. Fish was not noted in any of the original reports and may have been deliberately brought into the cave or unintentionally in the gut of an animal.



*Ungulates*: The ungulates identified are reindeer (*Rangifer tarandus*), red deer (*Cervus elaphus*), horse (*Equus* sp.), pig (*Sus* sp.), sheep (*Ovis aries*) and large bovidae, either auroch or bison (*Bos/Bison*).

Three post-cranial fragments were tentatively identified as auroch/bison; the lateral half of the lateral condyle of a metapodial, and diaphysis fragments of a radius and femur. The nature of preservation of the first two specimens, their discoloration and 'chalkiness', was similar. The posterior half of a calcaneum was identified as domestic cattle. The density of the bone suggested it was from an adult and it had some minor bony growth or exostosis around the sustentaculum. The *Bos* tooth, a maxillary molar, and a mandible fragment were also both from domestic cattle.

Domestic cattle bones and sheep, mainly teeth, were identified in Davies' first report on the animal bones from Aveline's Hole, although he later withdrew his identification of the former in his second report (Davies, 1922, p. 114). In his third report, domestic cattle, sheep and pig bones were all recorded but these apparently were represented by whole skeletons and had a different appearance to the bones of other animals, such as those of the 'giant deer' and reindeer (Davies, 1923, p. 12). The cave had been open since its discovery in 1797 and the implication is that the remains of domestic animals were introduced into the cave since that time (*ibid.*). Skinner (1824, p. 128) specifically notes that sheep were entering the cave and disturbing the deposits in the early nineteenth century.

In addition to the domestic cattle bones, sheep and pig bones are also represented in the surviving collections. The presence of pig was noted in the original reports, specifically a 'large, very worn, highly mineralised incisor' (Davies, 1921, p. 67), 'part of a mandible and tooth' (Davies, 1923, p.11), and two perforated teeth accompanying a double 'ceremonial burial' identified as the upper canines of a female pig (Davies, 1925, p. 107). Concerning the last, while the teeth themselves cannot be located, a photograph of them (Davies, 1925, Plate VII.6) is sufficient to show that they are male cervid canines, probably red deer, and not pig. A pig humerus from the 'exterior of the cave' is also recorded in the UBSS General Log (18.7.27) and other pig bones, considered to be recent, were noted when moving the old spoil heap (Davies, 1923, p.12). It is probable that the two surviving specimens, a deciduous premolar and phalanx, derive from the latter context. Thus the presence of pig in any early context cannot be confirmed.

Red deer was represented in the surviving collections by a range of cranial and post-cranial elements and by some of the small antler pieces. One of the red deer phalanges in the NHM exhibits cutmarks, and this specimen has yielded an AMS determination of  $12380 \pm 130$  BP (OxA-1121) (Hedges *et al.* 1987). This was originally misidentified as bovid but is in fact cervid, as Jacobi (this volume) has noted. Deer were remarked to be one of the most abundant species at the site, with repeated reference to the presence of both red deer and 'giant red deer' (Davies, 1921, pp. 63-67; 1923, p. 11). In the fourth report it becomes clear that 'giant red deer' is intended to refer to *Strongyloceros spelaeus* (Davies, 1925, p. 112). A comparable situation occurred with the Kent's Cavern fauna where the large red deer bones were nearly the size of those of the Giant Irish deer or 'elk' (*Megaloceros giganteus*) and as a result were designated as a different species, *Strongyloceros spelaeus*, by Owen (Lister, 1987). The few surviving red deer bones from Aveline's Hole are all notably large, but this may be a feature of the species in the Late Glacial; the presence of both large and small individuals referred to by Davies could relate to sexual dimorphism. Alternatively, the small red deer referred to in the reports could be misidentified reindeer. No Giant Irish deer bones are present in either the surviving UBSS or NHM collections nor has its presence at Aveline's Hole been noted amongst the extensive records for the animals' remains from across Britain (Yalden, 1999, pp. 37-39).

In the early reports, reindeer remains were noted as a frequent occurrence in the site deposits, but only shed antler specimens, and no post-cranial elements, were identified (Davies, 1923, p. 11; Davies, 1924, p. 112). In contrast the surviving assemblage has a minimum of sixteen positively identified reindeer post-cranial bones while the antlers comprise two shed specimens and one unshed antler with fragmentary adjoining frontal bone. Three heavily gnawed cervid navicular-cuboids and a carpal were also present in the NHM assemblage. Their identification was not verified but they are probably of reindeer given their size, since the red deer bones from the cave were all exceptionally large.

Horse bones, in particular tarsals and phalanges, were noted in the original reports (Davies, 1921, p. 67; Davies, 1923, p. 11) and in the UBSS General Log. The presence of horse in the surviving collection is limited to a single ulna fragment (part of the olecranon process), which is poorly preserved.

*Carnivores:* Six carnivores were identified; red fox (*Vulpes vulpes*), arctic fox (*Alopex lagopus*), dog/wolf (*Canis* sp.), wolf (*Canis lupus*), lynx (*Lynx lynx*), wild cat (*Felis silvestris*) and badger (*Meles meles*). Brown bear (*Ursus arctos*), noted in the excavation reports as abundant in some parts of the cave (Davies, 1921), does not appear to be represented in the surviving assemblage. The gnawing marks noted on some of the assemblage may be from human or animal gnawing as no distinct punctures from small and sharp canines that would clearly identify the gnawing of, for example, a fox or lynx, were noted. Davies (1922, p. 114) states that the many fox bones found were 'always extensively gnawed, and often show such definite signs of cutting as would be made by stone implements'. He goes on to attribute the gnawing to humans, commenting that they must have been an 'Upper Palaeolithic delicacy' (*ibid.*).

Bones of red fox (*Vulpes vulpes*) were relatively common in the surviving collections; teeth of this animal were noted as being particularly abundant in the excavation reports (Davies 1921, p. 67). In addition a humerus of an arctic fox (*Alopex lagopus*), a species not noted in any of the published reports, was positively identified. Arctic fox is one of the less common carnivores during the Late Glacial (Yalden, 1999, p.43) but has been recorded from nearby Gough's Cave and dated to 12400 ± 110 BP (OxA-1200) (Hedges *et al.* 1988). This is the latest known record for this animal and presumably it became extinct soon thereafter (Corbett and Harris, 1991, p. 572).

Dog/wolf (*Canis* sp.) was represented by four first phalanges, a calcaneum and an astragalus. The phalanges all had unfused proximal epiphyses; they were less than two centimetres in length and burnt. The variable size and shape of the phalanges and their comparable states of fusion suggest that they represent the lateral and medial phalanges from the same individual and probably from a single front or hind paw. While Davies noted the presence of 'scorched or fire blackened' giant deer and bear specimens from 'The Shaft' in his fourth report (Davies, 1925, pp. 106-107), these phalanges were more likely burnt during the 1940 fire. A number of human phalanges are burnt in the same way, suggesting that a group of these elements were stored together. An unburnt immature canid calcaneum and astragalus stored in the NHM may have originated from the same young animal, which would also lend support to a recent date for the burning of the phalanges in Bristol. Davies (1921, p. 67) noted the presence of the maxilla of a domestic dog in the first report, found a few inches below the well-known bilaterally barbed antler harpoon point, but this identification was later retracted in favour of a large fox (Davies, 1922, p. 114). Unfortunately, the surviving immature specimens do not permit a definite identification as *Canis familiaris* although the good state of preservation of the porous ankle bones might suggest that they are modern, and therefore from a young dog

(though preservation conditions in the cave were clearly highly variable, as some extremely well-preserved human ulnae are included among those dated). One metacarpal is of a size that can more confidently be identified as wolf.

Felidae are represented by two postcranial bones each of wild cat and lynx. An ulna of the latter bears distinct transverse cutmarks on its shaft, probably relating to skinning. An attempt by Roger Jacobi to date this specimen failed due to contamination by glues. The other surviving carnivore bones were two badger metacarpals.

*Lagomorphs*: Bones of hare were the most numerous specimens in the surviving collection, consistent with Hinton's original report in which he noted that the bones and teeth of hare were very common. He also remarked that '...in so far as these remains are determinable specifically, all belong to *L. anglicus* (a characteristic late Pleistocene species), none to *L. europaeus*' (Hinton 1921, p. 75). In older literature *L. anglicus*, 'English varying hare', is the term often used for *L. timidus*, mountain hare (Yalden, 1999, p. 41). The distinction between the two native species; the mountain hare which is also known as blue, Irish or arctic hare, and the larger brown or European hare (*Lepus europaeus*); is difficult (Yalden, 1999, p. 17) but is usually made on cranial characteristics or complete longbone measurements (Corbet and Harris, 1991, pp. 154, 161). Most of the hare longbones stored in the NHM were either immature or fragmentary, a characteristic of the material also noted in the first report (Davies, 1922, p. 114). The assemblage however displayed a considerable heterogeneity in the size of the adult bones which could indicate either that there was quite a size-range in the mountain hare bones, which may be the case if the bones span a significant time period (see Yalden, 1999, p. 67), or, that in addition to mountain hare, brown hare is also represented. The latter was not verified but if it is the case then these, along with the bones of rabbit which were also recorded, must be relatively recent introductions into the cave.

That some of the lagomorphs were likely introduced and utilised by humans is indicated by the reported presence of a series of fine cutmarks along the surfaces of the ribs of a small mammal 'about the size of those of a rabbit' (Davies, 1922, p. 115).

*Rodents*: A number of the rodent mandibles in the UBSS collection were identified representing three species; field vole (*Microtus agrestis/arvalis*), lemming (*Lemmus lemmus*) and field mouse (*Apodemus sylvaticus*) and some rodent gnawing was also recorded on red deer and fox bones, as well as on a number of human bones.

In the original reports both Davies (1921) and Hinton (1921) identified *M. arvalis* (continental field vole), and not the native field vole, *M. agrestis*. *Microtus arvalis* is presently represented in Britain only by island races, on Orkney and Guernsey, and was probably introduced by Neolithic settlers (Corbet and Harris, 1991, pp. 203, 209). The size and morphology of the teeth of the two are closely comparable. Lemmings were the most common rodent, comprising 33% of the original rodent assemblage (Hinton, 1923, p. 37). The species is common in Late Pleistocene deposits.

#### *Discussion of the fauna*

As with the human remains, it is unfortunate that more of the faunal assemblage does not survive. An examination of cutmarks and other indications of butchery would no doubt aid in the interpretation of the function of the site, as would the presence of any seasonal indicators.

That at least some of the small mammalian fauna was introduced and utilised by humans is indicated by the reported presence of cutmarks on small mammal ribs, possible hare (Davies, 1922, p. 115). Charles and Jacobi (1994) have drawn attention to the possibility of

specialised hunting or trapping of hares in Late Upper Palaeolithic sites at Creswell Crags, Derbyshire. More broadly, Boyle (1990) discusses the significant presence of lagomorphs on a number of Late Upper Palaeolithic sites in southwest France and their potential dietary importance.

Other small mammals were also utilised. Fox bones and teeth in particular were noted as abundant in the excavation reports, with many reportedly showing gnawing and cutmarks (Davies, 1922, p. 114). This, together with the cutmarks on the NHM lynx ulna, suggests that at least some of these carnivores were hunted for their furs, though this does not preclude their use for food. In a review of the evidence for the exploitation of carnivores and other fur-bearing mammals (lagomorphs and beaver), Charles (1997) documents widespread use of carnivores for both meat and furs in the Late Upper Palaeolithic and Mesolithic of north-western Europe, including, among others, bear, wolf, fox, lynx, wild cat and badger, all species that are present at Aveline's Hole.

Human utilisation of the larger fauna at Aveline's Hole is indicated by the many ungulate long bones recorded as being split lengthwise for marrow extraction, including those of horse as well as deer (Davies, 1921, p. 67), and by the cutmarks noted on the red deer phalanx in the NHM. Whereas the reindeer antler was all identified as shed (though we now know that this is not the case), Davies (1925, p. 112) used the presence of unshed antlers representing some 30 'giant red deer' to argue for autumn hunting, mature antlers being present from mid-summer to mid-winter. While the specifics of this interpretation are open to question, the overall impression of the nature of the use of the site is certainly one of short-term stays, consistent with Jacobi's (this volume) conclusion based on the lithics that a special-purpose camp may be represented.

It seems probable that much of the human-introduced large and medium-sized mammals, as well as an unknown proportion of the small mammals, relates to a time when the cave was used for habitation (in the form of temporary encampments), preceding its use as a burial place. This would be in accordance with the lithic evidence, the majority of which sits more comfortably within the Creswellian (Jacobi, this volume). The reindeer and horse remains in particular suggest a Late Pleistocene context, though these species did survive into the early part of the Holocene (Clutton-Brock, 1986). The overlap of reindeer and temperate woodland fauna in the first half of the tenth millennium BP (ninth millennium BC) is clearly indicated by the radiocarbon dates compiled in Barton and Roberts (2004, Fig. 18.1). Aveline's Hole itself has a radiocarbon determination of  $9670 \pm 110$  BP (OxA-802) on shed reindeer antler, and nearby Gough's Cave has reindeer dating to  $9920 \pm 130$  BP (Q-1581) (Jacobi, 1987, Tab. 15.1). Two cave sites in the Wye Valley have reindeer at  $9930 \pm 90$  BP (OxA-6839) and a very late horse at  $7440 \pm 70$  BP (OxA-8168) (Bronk Ramsey *et al.*, 2002). Assuming his identifications can be accepted, Skinner (1819, pp. 106-107) noted the presence of both deer and horse bones in close association with the human remains, though this need not necessarily imply contemporaneity. It is noteworthy that the small surviving collection includes the presence of reindeer postcrania, as these were not mentioned in the original reports, which refer to the presence of shed antler exclusively (Davies, 1923, p. 11; 1925, p. 113).

On the other hand, arguing against an overly strict attribution of the fauna to an earlier component at the site, it is clear that some animal remains do seem to have been closely associated with the human burials. A number of teeth of red deer were associated with the 'double ceremonial burial', together with an incised longbone fragment identified as a deer tibia (Davies, 1925, pp. 106-107). But then it is possible that this itself is an earlier burial. Red deer teeth and antler, and a bear tooth were also found in close association with another probable burial nearby (Davies, 1925, p. 112), though again this burial may also be earlier than the dated

group (see Marshall and van der Plicht, above). Any fauna that was associated with the burials is more likely to take the form of ornamentation or offerings. The most recent faunal date from Aveline's Hole (OxA-802:  $9670 \pm 110$  BP, 9300-8750 BC), on what is identified as a shed reindeer antler, still considerably predates the burials, by at least three or four centuries to as much as a millennium. Aurochs, if present, is often seen as a Holocene species, but was clearly present in the Late Glacial, including at Gough's Cave (Currant, 1991; Housley, 1991). The presence of pig noted in the original and present reports supports a Holocene date for at least some of the fauna, but then these may be very recent remains, belonging with the sheep and domestic cattle also found. An accelerator radiocarbon determination on either the single surviving pig bone or the tooth may be warranted. Currently, no fauna suggesting habitation can be definitely linked with the period of the use of the cave for burial, consistent with the idea that its role was limited to a mortuary one at this time.

### POLLEN ANALYSIS AND LOCAL ENVIRONMENT (V. Hall and R. Schulting)

Tundra-like conditions likely prevailed in the Mendips until about 9000 BC, after which the rise first of open birch-pine woodland and then of varying density deciduous forest changed the landscape considerably (Campbell and Gordon, 1998). Temperature at the beginning of the Holocene rose quickly, as much as  $5-7^{\circ}\text{C}$  over a few decades, as shown by ice core data and beetle evidence (Alley *et al.*, 1993; Atkinson *et al.*, 1987; Dansgaard *et al.*, 1989; Lowe *et al.*, 1995), though there may have been some lag in vegetation changes (Bennett and Preece, 1998; Caseldine and Maguire, 1986). The highest exposed parts of the Mendips (*c.* 300 m) may have remained relatively open well into the early Holocene (*cf.* Campbell, 1998), and so could have provided attractive hunting and gathering conditions at certain times of the year. A more open environment may have been maintained by judicious burning by Mesolithic communities, a strategy for which there is evidence from the Late Mesolithic on Dartmoor, Devon (Caseldine and Hatton, 1993).

Unfortunately excavations at Aveline's Hole predated the widespread use of palynological analysis on archaeological deposits, and so no sediment samples were collected. Suitable pockets of sediment may survive in parts of the cave, and could form the focus of future research. Here, a different exploratory approach was taken, and sediments from the medullary cavities of four long bone shafts were sampled for palynological analysis (M1.13.156, M1.13.160, M1.14.50 and M1.14.115) in an attempt to learn more about the local environment at or near the time of burial (*cf.* Churchill, 1963). The rationale for this is that once the cavities did become filled with sediment, this would prevent any subsequent entry by later sediments. Evidence for the sealing of the cave, either accidentally or intentionally, not long after its use for burial may strengthen the conclusions. This may have prevented or minimised contamination by later in-washing sediments. Thus, even if the broken bone shafts were not filled with sediment until many years after burial, the sediments themselves may still largely relate to the period of use of the cave.

Pollen was found in three of the four samples. The most interesting results were obtained on sediments from M1.13.160 and M1.14.115, an ulnar and a femoral shaft, respectively. Too little pollen is present in these samples to provide any quantitative data. Nevertheless, the former contained small numbers of eroded birch (*Betula*) and pine (*Pinus*) pollen grains, while the latter held birch only, in a very degraded state. Sediment from the humeral shaft (M1.13.156) contained larger quantities of pollen in a much better state of preservation,

comprising grasses and weeds of the dandelion (*Taraxacum*-type) and ragwort groups (*Senecio*-type).

All of the above species would be expected in the early Holocene environment on the Mendips. Pine and birch are classic indicators of the Boreal period and their pollen is unlikely to be recent in south-west England (Bennett, 1984; Birks 1989; Godwin, 1975). Their rise was documented in palynological studies at the Mendip sites of Gough's Cave and Badger Hole, though the chronology is largely a relative one (Campbell, 1977, pp. 97-99, Figs. 69-70). Earlier periods (*i.e.*, the Late Glacial and pre-Boreal) would be expected to include juniper (*Juniperus*) and willow (*Salix*), while more recent periods would include temperate species such as alder (*Alnus*), hazel (*Corylus*) and oak (*Quercus*). Thus, it does seem that at least some of the pollen in the medullary cavities could indeed relate to local conditions near the time of burial. The grasses and weeds from the humeral shaft, while far more ubiquitous, are species that would also have been present in the relatively open birch-pine woodlands of the period. These tentative conclusions do need to be treated with appropriate caution in light of the uncertain temporal associations between the placement of the human remains in the caves, the infilling of broken bone shafts by pollen-bearing sediments, and the ultimate source of the pollen in those sediments.

## MINERALOGICAL ANALYSIS

(R.I. Macphail)

Four small bulk samples from Aveline's Hole were collected from broken long bone shafts. Three of the bulk samples were visibly different from the fourth, and ways were sought to determine this difference and if possible elucidate further information on the included sediment, if possible to aid the investigation on the taphonomy of these bones. One possibility being investigated was that some of the human skeletal material had originally been deposited elsewhere before being brought to the cave. A second possibility was that, due to the tumultuous history of the collection, some material from other sites had become mixed in. As the samples were so small it was decided that a mineralogical study through XRD (X-ray diffraction) would be the best way to gain an insight into the nature of this included material.

### *Methods*

Visual and binocular examination of the sediments was carried out before the material was sub-sampled for XRD (Department of Chemistry, University College London).

### *Results*

Samples M1.14.115, M1.13.155 and M1.14.50 are composed of dark orange coloured (weakly ferruginous?) fine material (silt and clay) with admixtures of medium to coarse sand. There was not enough sample to produce moist Munsell colour data. Sample M1.13.160 differed by being pale coloured, with a possible included bone fragment.

The results of XRD analysis are given in Table 14. Clearly samples M1.14.115, M1.13.155 and M1.14.50 have a totally different mineralogy compared to sample M1.13.160, by containing:

Quartz (ubiquitous detrital mineral),  
 Calcite (common detrital mineral; dominant constituent of limestone; dominant constituent of stalagmite/speleothem),  
 Dolomite (common constituent of 'magnesium' limestone),  
 Albite and Microcline (common feldspars derived from granite),  
 Chlorite and Muscovite (common phyllosilicates/'clay' minerals),  
 Hematite (common relict iron mineral, responsible for 'ferruginous staining'), and  
 Rutile and Hornblende (not uncommon 'heavy' minerals);

while in sample M1.13.160, XRD found only calcite, and some unrecognisable materials. Despite the fact that the many phases of calcite could be obscuring other minerals, it is clear that sample M1.13.160 is dominated by calcite.

<i>Sample</i>	<i>Quartz</i>	<i>Calcite</i>	<i>Dolomite</i>	<i>Albite</i>	<i>Microcline</i>	<i>Chlorite</i>	<i>Muscovite</i>	<i>Hematite</i>	<i>Hornblende</i>	<i>Rutile</i>
M1.14.50	+	+	+		+	+	+	+	+	+
M1.14.115	+	+	+	+	+	+	+			+
M1.13.155	+	+		+		+	+	+		+
M1.13.160		+								

**Table 14.** *Mineralogical analysis (XRD) of four sediment samples collected from broken long bone shafts from Aveline's Hole (+ = present).*

#### *Discussion and conclusions*

It can be suggested that the difference in mineralogy between the samples may simply reflect infilling of M1.13.160 by calcite, during the period of stalagmite/speleothem formation that affected the site and which embedded a skull and formed the 'stalagmite floor'; while the other fragments were open to infilling by sediment inwash. The embedding and cementation of bones and rock fragments by calcite to form a breccia is a typical karstic phenomenon in limestone caves. In the case of samples M1.14.115, M1.13.155 and M1.14.50, it is likely that inwashed sediment included detrital calcite and dolomite from the local limestone, although some weak impregnation by secondary calcite probably also took place.

The Mendips had a dark orange coloured decalcified soil/sediment cover during the Quaternary and some of this material was washed or slumped into caves such as Westbury-sub-Mendip and Gough's Caves. At Gough's Cave, sediment inwash adhered to Upper Palaeolithic human bones in the main chamber. In a side chamber ('Frog Hole') speleothem formation affected the earliest Holocene deposits, and this period of speleothem deposition may well coincide with stalagmite development at Aveline's Hole.

The mineral infilling of sample M1.13.160 seems to relate to a calcitic cementation (and cavity infilling) of this long bone fragment (into a stalagmite?), whereas void space within

the other long bone samples appears to have occurred through inwash of fine 'cave earth' likely derived from the decalcified regolith and limestone rock that covered the Mendips. The sediment within these bones was probably also weakly impregnated by secondary calcite during the Holocene. Local processes can account for all the sediments.

#### SEA LEVELS (R. Schulting)

Reconstruction of sea-levels for the early Holocene is a complex undertaking, and different researchers have proposed quite different models. In an early effort, Hawkins (1971, Fig. 3) modelled sea-levels changes in southwest Britain suggesting that at *c.* 9000 BP the sea was as much as -45 m relative to modern H.W.S.T. Subsequent research by Heyworth and Kidson (1982) is widely acknowledged as the most thorough for the Bristol Channel (Shennan, 1983). Using the curves supplied in Heyworth and Kidson (1982, Fig. 5), sea-levels in the Bristol Channel at *ca.* 9000 BP (8200 cal BC) were about -35 m below present levels, though it is recognised that further study is required to reconstruct the position of the palaeo-coastline at any given date. Flemming (1982, Fig. 7) models a UK-wide correction for isostatic uplift that suggests that sea-levels at *c.* 9000 BP were about -20 to -25 m below present, though again he cautioned that more data are required, particularly for the tenth millennium BP (*ibid.*, p. 120). In a series of papers Kidson and Heyworth have argued that the Bristol Channel area has remained isostatically stable, though not all agree with this assessment (discussed in Shennan, 1983, pp. 265-268). More recently, Fairbanks (1989, Fig. 2) reported a detailed record of global sea-level change based on offshore coral reefs around Barbados that is more in agreement with the early figures proposed by Hawkins, suggesting a lower sea-level of about -45 m O.D. at 9000 BP. This correspondence led Allen (2001, Fig. 4) to return to Hawkins' earlier estimates. What is apparent, regardless of which particular curve is employed, is that the period between 10,000 and 7000 BP witnessed very rapid sea-level rise, and that this was especially pronounced between about 9500 and 8000 BP (Campbell, 1998; Fairbanks, 1989; Pirazzoli, 1991, Plate 21 upper; Shennan and Horton, 2002). This would have resulted in the inundation of a large area of what is now the Bristol Channel (Shennan *et al.*, 2000, Fig. 5a, b). Using the reconstructed sea-levels, Aveline's Hole would have been some 80-100 km from its contemporary coastline (Figure 32).

#### DISCUSSION (R. Schulting)

With up to some 50 or more skeletons once present, Aveline's Hole is one of the largest Early Mesolithic burial sites in Europe. If this number is in doubt, the present study confirms the presence of least 21 individuals, including adult men and women, and subadults ranging from neonatal to adolescent, of which 18 have now been directly dated to the late ninth millennium BC. Other human remains from the Mendips dating to approximately the same period are known from Gough's Cave ('Cheddar Man') and Badger Hole (Schulting and Wysocki, 2002, Table 1). One radiocarbon date from a group of four (three adults and one child) individuals from Totty Pot indicates that at least some of these are later by approximately one millennium (Ambers and Bowman, 2003).



While there is evidence for Creswellian (12900-12000 BP) use of Aveline's Hole, represented by lithics (Jacobi, this volume, 1997), fauna, an antler harpoon, and possibly the double 'ceremonial burial', the early Holocene use of the cave seems to have been more or less exclusively for burial. The fauna and hearths mentioned above do suggest occupational use of the cave, but the date of these relative to the burials is not certain, though there are indications that they are more likely to relate to the earlier period. The hearths are also noted as being very thin and do not represent long-term occupation (Davies, 1925, p. 113). There may also be some slight evidence for a degree of spatial separation with the flints and fauna nearer to the cave entrance, and the burials further into the cave, though this is tentative at best given that early accounts do refer to skeletons being found near the entrance. Another possibility worth considering is that some of the hearths and the fauna, if of the same date as the burials, could relate to funerary rites and associated feasting. This can certainly be argued for the 'ceremonial burial' found beneath a hearth; 18 deer incisors that may be associated with the burial all show scorching (Davies, 1925, p. 107). Some of the faunal remains from elsewhere in the cave are also reported as being scorched (*ibid.*). While there are no clear indications of burning on the surviving human bone, other than what has been attributed to burning during the Blitz, Fawcett (1922, p. 81) does note that 'some of the [human bone] fragments have the appearance of having been partially burned'.

The two earliest published accounts (Anon. 1797), describe the skeletons as 'lying promiscuously', while Wansey's (1805) account describes them as 'perfect'. Skinner's (1819, pp. 106-107) later account, given to him by one of the men to have originally entered the cave, also describes 'several of them being quite perfect, with their heads placed against the rock'. The key difference lies in the use of the term 'promiscuous', which may either refer to a disarticulated jumble, or, as Graham Mullan has suggested (*pers. comm.* 2005), to the fact that the bones were not 'properly' interred in individual coffins, or even buried at all, but lay directly on the cave floor. That later accounts do refer to at least some skeletons as 'perfect' and offer a count of the number of individuals indicates that at least some bodies were more or less complete and articulated, particularly since the intervening years between the first and subsequent accounts would be expected to lead to increased disturbance in the cave. Furthermore, disarticulated groups of human remains would probably have warranted more specific comment in 1797 than given by the term 'promiscuous'.

Further support for the placement of complete bodies in the cave comes from the presence of many small bones of the extremities (see Figure 8). Scattered and disarticulated remains were undoubtedly present as well, but whether these relate to secondary burial or to the disturbance of earlier skeletons by the addition of later ones, and possibly other activities occurring in the cave, cannot be determined on the basis of the available evidence. Unlike the Creswellian remains from Gough's Cave, there are no cutmarks on the Aveline's Hole human bone suggesting defleshing or intentional disarticulation. Nor is there evidence for the characteristic weathering of the bone that would occur had it been exposed to the elements. Finally, the XRD analysis, while very limited, suggests that the sediments in the medullary cavities of the longbones derive from the cave itself (as opposed to skeletal parts disinterred and brought to the site from other locations). Thus, on the available evidence it seems probable that many individuals were originally complete and articulated, *i.e.*, the cave held primary interments. Whether secondary burials were also present is unclear, though the practice would not be out of place for the Mesolithic (e.g., Petit Marais in northern France, Ducrocq *et al.*, 1996; see also Cauwe, 1998).

The undisturbed nature of the reportedly complete skeletons lying on the surface of the cave floor upon its discovery, together with the apparent total absence of later prehistoric or

historic remains, strongly suggests that the cave was sealed off in the early Holocene, by the beginning of the eight millennium BC (cf. Davies, 1921, p. 71). The interesting question becomes whether this was intentional or not. Davies argues that the sealing was due to an accidental rock fall, while Skinner's (1824, pp. 127-128) account suggests that intentional sealing is a distinct possibility (Figure 4). The short duration of the cave's use for burial in the Early Mesolithic is emphasised by the results of the new dating programme. On the basis of the dates obtained, the onset of burial at the site is estimated with a 95% probability to have been within the period 8460-8290 BC, and the cessation of burial within the period 8260-8140 BC. This suggests a very restricted period of use over, at the most, a century or two, and possibly much less, although the Bayesian model does not support a single, simultaneous event (though this would hardly be expected in any case). Even if two centuries are represented, this is a remarkably tightly constrained duration for a site of this nature, since typically caves with multiple interments show extended use over many centuries. A somewhat later human bone date (OxA-1070, 8200-7590 BC) may suggest continued intermittent use of the cave some centuries after the main group, but it may also be an statistical outlier (see Marshall and van der Plicht, above). Unfortunately the specimen (humerus M1.13.146) could not be located for re-sampling. That the cave may have seen some later activity is also tentatively suggested by what could be two Late Mesolithic microliths, though the date range for these cannot be precisely stated (Jacobi, this volume).

Knowing the approximate duration of use of the site, and assuming that at least 50 individuals are represented, can anything be said about the size of the population using Aveline's Hole for burial? This is a difficult question, but some general parameters can be proposed. Simple modelling suggests that the groups using the site for burial need not have been large, if all their dead were placed in the cave. Assuming random annual birth and mortality rates of between 2 and 4% (reasonable for pre-industrial populations), a small band of only 25 individuals could account for 50 deceased members over some 60-70 years. A larger group of say 100 individuals would obviously take correspondingly less time. But it is a very rare situation where we would expect all the dead of an ostensibly mobile hunter-gatherer community to be interred in the same place, so that these are likely to be minimum estimates. Subadults are likely to be underrepresented at Aveline's Hole, though they do comprise some 25% of the surviving skeletal assemblage. While this is within the lower end of the range of subadult mortality to be expected in pre-industrial populations (Weiss, 1973), it is probable that young infants are underrepresented.

Why was Aveline's Hole, and the Mendips in general, used so intensively (with respect to the early Holocene) for burial over such a brief period? Caves themselves tend to be perceived as unusual, liminal places in many societies, and are often used for burial, and this may well have been the case with Aveline's Hole (cf. Barnatt and Edmonds, 2002 on the Neolithic and Bronze Age). From the paucity of lithics, neither this site nor the other Mendip caves appear to have been important as places of either temporary or longer term occupation during the Mesolithic. Thus, the importance of the site does not relate to its use for contemporary habitation. It is possible that Aveline's Hole and Gough's Cave instead were important as mythic places in the landscape, perhaps relating to memories of their earlier (Creswellian) use by distant 'ancestors' preserved in oral traditions and reinforced by the encounters of those visiting the caves with recognisable but very different worked lithics, and the bones of animals either rare or relatively recently become locally extinct. The possibility of earlier burials in the cave, while not confirmed by the present study, is an intriguing one in this respect.

At the same time, it must be acknowledged that our own perception of the importance of cave burials in the Mendips, and indeed across southwest Britain in general, is undoubtedly

being exaggerated by their high archaeological visibility, and by their favourable preservation conditions. As the calculations above show, only a very small proportion of the deceased were ever placed in caves, with the majority presumably placed elsewhere in the landscape. That many skeletons were visible immediately upon the first entry into the cave in 1797 suggests that they were not buried, but were placed directly on the cave floor. Obviously, the survival of bone would be very low if this was a wider practice also taking place in non-cave locations. Placement of the deceased on the ground in the open air, covered only with brushwood, is a practice not unknown in the ethnographic record of hunter-gatherers (e.g., Teit, 1900).

The acoustic qualities of the stalactite noted by the first discoverers of the cave (Gibbes, 1800; Skinner, 1824, pp. 127-128) raise an intriguing possibility as to why this particular cave may have been selected as a special place for burial. The importance of sound in prehistory is an area of research that is being increasingly recognised, for example through studies of the acoustic qualities of Upper Palaeolithic rock art sites in France (Reznikoff and Davois, 1988). It is possible that the presence of a ringing stalactite 'heard at a considerable distance beyond the mouth of the cave' (Gibbes, 1800, p. 144) may have enhanced the otherworldly qualities of the cave and so promoted its use as a burial site. However, given the rates of calcium carbonate deposition, it is unlikely that the stalactite noted in the early accounts existed in anything approaching the same form during the period the cave was in use. One might speculate (recognising it as just that) that a similar formation may have been present, since the onset of speleothem formation may have coincided with the beginning of the Holocene (see Macphail, above). This receives some support from the dating of the stalagmite inside the cranium of A.H.1 (Buckland's skull 'O') to  $8100 \pm 50$  BP (GrN-5393) (Vogel and Waterbolk, 1972); though this is later than the burials, it does demonstrate that stalagmite was actively forming in the cave from an early period. But this would then also apply to other Mendip caves, such as Gough's.

Aveline's Hole is not the most dramatic location in the Mendips, which honour must go to sites such as Gough's Cave in Cheddar Gorge to the south. But Burrington Combe does provide one of the main routes from the north onto the central plateau of the hills (cf. Norman, 1982), as demonstrated today by the presence of the B3134 road running only some 10 m from the entrance to the cave. Attaining a maximum elevation of 325 m, the Mendips as a whole rise above and dominate the surrounding flat landscape (though this is seen more dramatically from the south). The selection of a prominent location for burial could suggest a concern with visibility of the dead in the landscape, which in turn could be interpreted as a claim to the land at some level. As noted above, this needs to be balanced by acknowledging that the high archaeological visibility of caves, and the excellent preservation conditions of the limestone hills, provide for a strong bias in the survival and recovery of early prehistoric burials from the Mendips. This consideration aside for the moment, and assuming that the concentration of early Holocene burials in the Mendips is real, how might it be interpreted?

It is worth exploring further the idea that the burials at Aveline's Hole may represent at least in part an interest in marking a territorial claim (an idea first mooted by Jacobi, 1987). This is a familiar explanation for the presence of formal cemeteries (Charles and Buikstra, 1983; Goldstein, 1981; Saxe, 1970), and the use of this term seems justified in the present case. While such explanations are more familiar for Early Neolithic mortuary monuments (Bradley and Chapman 1984; Renfrew 1976; Chapman 1981), some concern with territoriality has been postulated for the Late Mesolithic, particularly in coastal or riverine locations (Fischer, 1982; Larsson, 1984; Lillie, 2004; Price, 1985; Radovanovic and Voytek, 1997; Rowley-Conwy, 1998). Yet can the concept be usefully extended to an inland site in the Early Mesolithic? As noted above, population density in the early Holocene is thought to have been low, and

settlement mobility high. These are not conditions under which a strong concern with denoting territories is expected to emerge. Nor is it clear why the Mendips should form the focus of any claims either to land in general or to specific resources. Aquatic situations often concentrate resources, yet there is no large river or lake in the area, and the site was far from the contemporary coast. In fact, there is relatively little evidence for contemporary settlement on the Mendips and in north Somerset in general. The small number of diagnostic Early Mesolithic flints that are found in the area seem to mainly be isolated finds, possibly representing hunting losses (Gardiner, 2001, p. 107). The larger and more varied flint assemblage from Birdcombe some 15 km north of Aveline's Hole belongs to the Late Mesolithic, as do smaller assemblages from Totty Pot and Hay Wood Cave on the Mendips themselves (Gardiner, 2001). The nearest sizeable Early Mesolithic lithic assemblages are found some 25-35 km to the south, at Shapwick, Middlezoy and Greenway Farm (Norman, 1982; Wainwright, 1960), where a good proportion of the assemblage is made up of Greensand chert, a material not seen at Aveline's (this division in the sources of lithic raw materials between north and south Somerset seems to persist into the Late Mesolithic [Norman, 2001]).

But there is something about the early Holocene that is rather exceptional. Sea-levels at this time rose rapidly (Heyworth and Kidson, 1982; Fairbanks, 1989; Pirazzoli, 1991); this would have had a particularly dramatic impact on the plain of the future Bristol Channel, since the seas here today are relatively shallow. Following the discussion above, at *c.* 9000 cal BC, sea-levels would have been about -35 m O.D. By only half a millennium later, they would have been about -26 m O.D, and even this general trend could mask more rapid, punctuated rises. One impact of this must have been the submergence of the hunting and gathering territories of bands using that area, necessitating their movement either to the northwest or to the southeast. At some point the traditional territories of other bands would have been encountered, which could have led to the development of a certain tension over access to resources. And it is under such conditions that claims to territory can be expected to be made. The numbers of individuals affected would not have been large in absolute terms, in the hundreds at most; nevertheless, in relative terms, and in a situation of low overall population density, the displacement of numbers even of this order could have had an impact. This is tentatively offered as one hypothesis, with much still depending on the actual rate of sea-level rise and the resulting inundation experienced by local groups.

It is equally important to attempt to account for the apparent cessation of the use of the Mendip caves for burial after only a few centuries. While this refers to Aveline's Hole in particular, it is worth noting that dates for Gough's Cave 1 and Badger Hole fall within the same period, though the human remains from Totty Pot are significantly later. In fact, within the immediate environs of the Mendips, there is currently no evidence for cave burial at all between the late eighth millennium BC represented by Totty Pot and the mid-fourth millennium BC (*i.e.*, the Neolithic), when burials are known from a number of cave sites, including Hay Wood, Picken's Hole, Chelm's Coombe, Flint Jack's and Backwell (Ambers and Bowman, 2003; Hedges *et al.*, 1997; Lewis, 2000). Indeed, there is nothing approaching the scale of the Aveline's Hole cemetery across all of Britain until the appearance of communal tombs in the Early Neolithic, some 4000 years later. Why should territorial claims, if this is what the cemetery represents, no longer be important? One possibility is that, with time, disputes over the use of specific territories were resolved, as groups reached new social arrangements, and as a new population-resource balance was attained, obviating the need to make territorial claims (*i.e.*, social realignments could mean that there was no one against which to make such claims). Where the dead of the intervening period were interred is a very pertinent question, and indeed

it applies more widely than to just southwest England, as there is very little evidence for burial in the later Mesolithic of Britain full stop (Chamberlain, 1996; Schulting and Richards, 2002).

While the argument that rising sea levels could have been, indirectly, an impetus for the sudden appearance of a formal cemetery at this time is an intriguing one, there are considerations militating against it. Foremost among these is that the appearance of multiple interments in caves is apparently quite widespread in western Europe in the mid- to late-ninth millennium BC. The closest point of comparison with the Mendip sites is Worm's Head on the Gower peninsula, Glamorgan (Figure 32). Four individuals here have been dated to *c.* 9700 cal BC (Schulting, 2005.) While not on the same scale as Aveline's Hole, this is nevertheless suggestive of a formal burial site, particularly as there is little evidence of the cave's use for occupation. But in this case it may be possible to invoke the same explanation, since Worm's Head would be in a similar position to the Mendips for groups forced to abandon the Bristol Channel and Swansea Bay, moving to the northwest.

At first glance it is not possible to subject other cases to the same explanation. The earliest Holocene cemetery in Europe may be Vasilevka III in the Ukraine, with as many as 40 individuals, and three radiocarbon estimates placing at least some of these in the late tenth millennium BC (Lillie, 2004; Potekhina and Telegrin, 1995). The site of Padina on the Serbian side of the Iron Gates Gorge is of comparable age to Aveline's Hole (Boric and Miracle, 2004). These sites are clearly not affected by rising sea levels. Yet, once again, in the case of both Vasilevka and Padina, an element of territoriality may be invoked, relating not to the sea but to the position of these sites at strategic locations near rapids on major rivers, the Dneiper and the Danube respectively, with access to highly productive fish runs (Lillie, 2004; Lillie and Richards 2000). And in this case these areas see later Mesolithic as well as Early Neolithic cemeteries (Potekhina and Telegrin, 1995), suggesting a more persistent contestation of rights of access.

More problematic are a number of burials dating to the ninth millennium BC in a series of Belgian caves, including in particular La Grotte Margaux, but also Abri des Autours, Petit Ri and Loverval (Bronk Ramsey *et al.*, 2002; Cauwe, 1995, 1998, 2001). The North Sea would not be inundated until much later (Coles, 1998; Shennan *et al.*, 2000), and so in this area there would be no loss of territory forcing the movement of communities at this time. Of course, the area that finally was lost to rising sea-levels here would have been enormous, and presumably would have brought about correspondingly greater population displacements. What the reaction was to these events is at present not clear, though it is possible that the long-lived hut structures dating to the eighth millennium BC being found at sites such as Howick on the coast of northeast England may be one response from near the beginning of this process (Waddington, in press; Waddington *et al.*, 2003). Both burial and more permanent settlement can be used to mark claims to territories and resources being put under pressure by other groups.

The above discussion raises an interesting question concerning the scale at which explanation should be sought. Should a single explanation be sought for the apparent concentration of burials in the mid- to late-ninth millennium BC across such a large region? Or are more local and historical conditions paramount? At the moment it is not really possible to choose between these alternatives. Much depends on the reality of the apparent concentration of burials at this time, *i.e.*, is there anything here that requires explanation? At present I would maintain that there is, particularly in the case of Aveline's Hole.

The main goal of this paper has been to return Aveline's Hole and its finds to the attention of researchers interested in the Mesolithic period. While it has never been forgotten, the site has not in recent years achieved the recognition it arguably deserves, as one of the most

important early Holocene burial sites in Europe. While the unfortunate circumstances of the collections' history do present frustrating limits on what can be said, enough information survives to, at the very least, raise some interesting questions about people's lives and society at this time. The analyses presented here have by no means exhausted the potential for research on the collection. Perhaps a more immediate task should be to place the site first into its local and regional context, through targeted searching for additional Early Mesolithic sites in the Mendips and surrounding area, and through additional palaeoenvironmental research, but then also into a wider British and western European context.

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#### BIBLIOGRAPHY

- AERTS-BIJMA, A.T., MEIJER, H.A.J. and VAN DER PLICHT, J. 1997. AMS sample handling in Groningen. *Nuclear Instruments and Methods in Physics Research B*. **123**. 221-225.
- AERTS-BIJMA, A.T., VAN DER PLICHT, J. and MEIJER, H.A.J. 2001. Automatic AMS sample combustion and CO<sub>2</sub> collection. *Radiocarbon*. **43**. 293-298.
- ALLEN, J.R.L. 2001. Sea level, salt marsh and fen: shaping the Severn Estuary Levels in the Later Quaternary (Ipswichian-Holocene). *Archaeology in the Severn Estuary*. **11**. 13-34.

- ALLEY, R.B., MEESE, D.A., SHUMAN, C.A., GOW, A.J., TAYLOR, K.C., GROOTES, P.M., WHITE, J.W.C., RAM, M., WADDINGTON, E.D., MAYEWSKI, P.A. and ZIELINSKI, G.A. 1993. Abrupt increase in snow accumulation at the end of the Younger Dryas. *Nature*. **362**. 527-529.
- AMBERS, J. and BOWMAN, S. 2003. Radiocarbon measurements from the British Museum: datelist XXVI. *Archaeometry*. **45**. 531-540.
- AMBROSE, S.H. and NORR, L. 1993. Experimental evidence for the relationship of the carbon isotope ratios of whole diet and dietary protein to those of bone collagen and carbonate, pp1-37 in J.B. Lambert and G. Grupe (eds.), *Prehistoric Human Bone: Archaeology at the Molecular Level*, New York. Springer-Verlag.
- AMEEN, S., STAUB, L., ULRICH, S., VOCK, P., BALLMER, F. and S.E., A. 2005. Harris lines of the tibia across centuries: a comparison of two populations, medieval and contemporary in Central Europe. *Skeletal Radiology*. **34**. 279-284.
- ANDREWS, P., COOK, J., CURRANT, A. and STRINGER, C. 1999. *Westbury Cave. The Natural History Museum Excavations 1976-1984*, Bristol. CHERUB (Centre for Human Evolutionary Research at the University of Bristol).
- ANDREWS, P. and FERNÁNDEZ-JALVO, Y. 2003. Cannibalism in Britain: taphonomy of the Creswellian (Pleistocene) faunal and human remains from Gough's Cave (Somerset, England). *Bulletin of Natural History Museum London (Geology)*. **58 (suppl)**. 59-81.
- ANONYMOUS 1797. Untitled letter to the editor. *Sporting Magazine*. **9**. 283.
- ATKINSON, T.C., BRIFFA, K.R. and COOPE, G.R. 1987. Seasonal temperatures in Britain during the past 22,000 years, reconstructed using beetle remains. *Nature*. **325**. 587-592.
- BALCH, H.E. 1947. *Mendip: Its Swallet Caves and Rock Shelters*, London. Simpkin and Marshall.
- BARKER, H., BURLEIGH, R. and MEEKS, J. 1971. British Museum radiocarbon measurements VII. *Radiocarbon*. **13**. 157-188.
- BARNATT, J. and EDMONDS, M.R. 2002. Places apart? Caves and monuments in Neolithic and earlier Bronze Age Britain. *Cambridge Archaeological Journal*. **12**. 113-129.
- BARTON, R.N.E. 1994. Second interim report on the survey and excavations in the Wye Valley, 1994. *Proceedings of the University of Bristol Spelaeological Society*. **20**. 63-73.
- BARTON, R.N.E. 1996. Fourth interim report on the survey and excavations in the Wye Valley, 1996. *Proceedings of the University of Bristol Spelaeological Society*. **20**. 263-273.
- BARTON, R.N.E. and ROBERTS, A. 2004. The Mesolithic period in England, pp339-358 in A. Saville (ed.), *Mesolithic Scotland and its Neighbours*, Edinburgh. Society of Antiquaries of Scotland.
- BENNETT, K.D. 1984. The post-glacial history of *Pinus sylvestris* in the British Isles. *Quaternary Science Reviews*. **3**. 133-155.
- BENNETT, K.D. and PREECE, R.C. 1998. Palaeobotany, pp121-148 in R.C. Preece and D.R. Bridgland (eds.), *Late Quaternary Environmental Change in North-West Europe. Excavations at Holywell Coombe. South-East England*, London. Chapman & Hall.

- BIRKS, H.J.B. 1989. Holocene isochrone maps and patterns of tree-spreading in the British Isles. *Journal of Biogeography*. **16**. 503-540.
- BOCHERENS, H. and DRUCKER, D. 2003. Trophic level isotopic enrichments for carbon and nitrogen in collagen: case studies from recent and ancient terrestrial ecosystems. *International Journal of Osteoarchaeology*. **13**. 46-53.
- BOND, C.J. 2004. The supply of raw materials for later prehistoric stone tool assemblages and the maintenance of memorable places in central Somerset, pp128-143 in E.A. Walker, F. Wenban-Smith and F. Healy (eds.), *Lithics in Action*, Oxford. Oxbow Books and the Lithic Studies Society.
- BORIC, D. and MIRACLE, P. 2004. Mesolithic and Neolithic (dis)continuities in the Danube Gorges: new AMS dates from Padina and Hajdučka Vodenica (Serbia). *Oxford Journal of Archaeology*. **23**. 341-372.
- BOYLE, K.V. 1990. *Upper Palaeolithic Faunas from South-West France: A Zooarchaeological Perspective*, Oxford. British Archaeological Reports, International Series 557.
- BRADLEY, R. and CHAPMAN, R. 1984. Passage graves in the European Neolithic—A theory of converging evolution, pp348-356 in G. Burenhult (ed.), *The Archaeology of Carrowmore*, Stockholm. Theses and Papers in North-European Archaeology 14.
- BRONK RAMSEY, C. 1995. Radiocarbon calibration and analysis of stratigraphy: the OxCal program. *Radiocarbon*, **37**, 425-30. **37**. 425-430.
- BRONK RAMSEY, C. 1998. Probability and dating. *Radiocarbon*. **40**. 461-474.
- BRONK RAMSEY, C., HIGHAM, T.F.G., OWEN, D.C., PIKE, A.W.G. and HEDGES, R.E.M. 2002. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 31. *Archaeometry*. **44**. 1-149.
- BROTHWELL, D.R. 1965. *Digging Up Bones*, Ithaca. Cornell University Press.
- BROTHWELL, D.R. and BLAKE, M.L. 1966. The human remains from Fussell's Lodge long barrow: their morphology, discontinuous traits and pathology. *Archaeologia*. **100**. 48-63.
- BROTHWELL, D.R. and CULLEN, R. 1991. The human bone, in A. Whittle, Wayland's Smithy, Oxfordshire: excavations at the Neolithic tomb in 1962-63 by R.J.C. Atkinson and S. Piggott. *Proceedings of the Prehistoric Society*. **57(2)**. 72-80.
- BROWN, T. and MOLNAR, S. 1990. Interproximal grooving and task activity in Australia. *American Journal of Physical Anthropology*. **81**. 545-554.
- BUCK, C.E., LITTON, C.D. and SMITH, A.F.M. 1992. Calibration of radiocarbon results pertaining to related archaeological events. *Journal of Archaeological Science*. **19**. 497-512.
- BUCKLAND, W. 1823. *Reliquiae Diluvianae*, London. John Murray.
- BUDD, P., CHENERY, C., MONTGOMERY, J. and EVANS, J. 2003. You are where you ate: isotopic analysis in the reconstruction of prehistoric residency, pp69-78 in M. Parker Pearson (ed.), *Food, Culture and Identity in the Neolithic and Early Bronze Age*, Oxford. BAR International Series 1117.



- BURLEIGH, R. 1986. Radiocarbon dates for human and animal bones from Mendip caves. *University of Bristol Spelaeological Society*. **17**. 267-274.
- BUXTON, L.H.D. 1925. Notes on a skull, in the University Museum, Oxford, from Aveline's Hole. *Proceedings of the University of Bristol Spelaeological Society*. **2**. 115-119.
- CAMPBELL, J.B. 1977. *The Upper Palaeolithic of Britain*, Oxford. Clarendon Press.
- CAMPBELL, S. 1998. The geomorphological and Quaternary evolution of south-west England: a synthesis, pp18-44 in S. Campbell, C.O. Hunt, J.D. Scourse, D.H. Keen and N. Stephens (eds.), *Quaternary of South-West England*, London. Joint Nature Conservation Committee and Chapman & Hall.
- CAMPBELL, S. and GORDON, J.E. 1998. Introduction to the Quaternary, pp1-10 in S. Campbell, C.O. Hunt, J.D. Scourse, D.H. Keen and N. Stephens (eds.), *Quaternary of South-West England*, London. Joint Nature Conservation Committee and Chapman & Hall.
- CASELDINE, C.J. and HATTON, J. 1993. The development of high moorland on Dartmoor: fire and the influence of Mesolithic activity on vegetation change, pp119-131 in F.M. Chambers (ed.), *Climatic Change and Human Impact of the Landscape*, London. Chapman and Hall.
- CASELDINE, C.J. and MAGUIRE, D.J. 1986. Late glacial/early Flandrian vegetation change on northern Dartmoor, south west England. *Journal of Biogeography*. **13**. 255-264.
- CAUWE, N. 1995. Chronologie de l'Abri des autours à Anseremme-Dinant. *Notae Praehistoricae*. **15**. 51-60.
- CAUWE, N. 1998. *La Grotte Margaux à Anseremme-Dinant*, Liège. University of Liège, Études et Recherches Archéologiques Eraul 59.
- CAUWE, N. 2001. Skeletons in motion, ancestors in action: Early Mesolithic collective tombs in southern Belgium. *Cambridge Archaeological Journal*. **11**. 147-163.
- CHAMBERLAIN, A.T. 1996. More dating evidence for human remains in British Caves. *Antiquity*. **70**. 950-953.
- CHAMBERLAIN, A.T. and WITKIN, A. 2003. Early Neolithic diets: evidence from pathology and dental wear, pp53-58 in M. Parker Pearson (ed.), *Food, Culture and Identity in the Neolithic and Early Bronze Age*, Oxford. BAR International Series 1117.
- CHAMBERS, J.M., CLEVELAND, W.S., KLEINER, B. and TUKEY, P.A. 1983. *Graphical Methods for Data Analysis*, Boston. Wadsworth.
- CHAPMAN, R. 1981. The emergence of formal disposal areas and the 'problem' of megalithic tombs in prehistoric Europe, pp71-81 in R. Chapman, I. Kinnes and K. Randsborg (eds.), *The Archaeology of Death*, Cambridge. Cambridge University Press.
- CHARLES, D.K. and BUIKSTRA, J.E. 1983. Archaic mortuary sites in the central Mississippi drainage: distribution, structure, and behavioral implications, pp117-145 in J.L. Phillips and J.A. Brown (eds.), *Archaic Hunters and Gatherers in the American Midwest*, New York. Academic Press.

- CHARLES, R. 1997. The exploitation of carnivores and other fur-bearing mammals during the north-western European Late Upper Palaeolithic and Mesolithic. *Oxford Journal of Archaeology*. **16**. 253-277.
- CHARLES, R. and JACOBI, R.M. 1994. The Lateglacial fauna from the Robin Hood cave, Creswell Crags: a re-assessment. *Oxford Journal of Archaeology*. **13**. 1-32.
- CHISHOLM, B.S., NELSON, D.E. and SCHWARZ, H.P. 1982. Stable isotope ratios as a measure of marine versus terrestrial protein in ancient diets. *Science*. **216**. 1131-1132.
- CHURCHILL, D.M. 1963. A report on the pollen analyses of the muds from the medulla tissues of two fossil human skeletons: Tilbury Man and Thatcham Man. *Proceedings of the Prehistoric Society*. **29**. 427-428.
- CHURCHILL, S.E. 2001. Gough's Cave 1 (Somerset, England): a study of the pectoral girdle and upper limbs. *Bulletin of Natural History Museum London (Geology)*. **57**. 95-107.
- CLUTTON-BROCK, J. 1986. New dates for old animals: the reindeer, the aurochs, and the wild horse in prehistoric Britain. *Archaeozoologia Mélanges*. 111-117.
- COLES, B.J. 1998. Doggerland: a speculative survey. *Proceedings of the Prehistoric Society*. **64**. 45-81.
- CONSTANDSE-WESTERMANN, T.S. and NEWELL, R.R. 1989. Social and biological aspects of the Western European Mesolithic population structure: a comparison with the demography of North American Indians, pp106-115 in C. Bonsall (ed.), *The Mesolithic in Europe* Edinburgh University Press.
- COOK, J. 1986. Marked human bones from Gough's Cave, Somerset. *Proceedings of the University of Bristol Spelaeological Society*. **17**. 275-285.
- COOK, J. 1991. Preliminary report on marked human bones from the 1986-1987 excavations at Gough's Cave, Somerset, England, pp160-168 in N. Barton, A.J. Roberts and D.A. Roe (eds.), *The Late Glacial in North-West Europe: Human Adaptation and Environmental Change at the End of the Pleistocene*, London. Council for British Archaeology, Research Report 77.
- CORBET, G.B. and HARRIS, S. 1991. *The Handbook of British Mammals*, London. Blackwell Science.
- COWSH, A.W., MASON, E.J. and WAITE, V. 1962. *The Mendips*, London. Robert Hale.
- CURRANT, A.P. 1991. A Late Glacial Interstadial mammal fauna from Gough's Cave, Somerset, England, pp48-50 in N. Barton, A.J. Roberts and D.A. Roe (eds.), *The Late Glacial in North-West Europe: Human Adaptation and Environmental Change at the End of the Pleistocene*, London. Council for British Archaeology, Research Report 77.
- CURRANT, A.P., JACOBI, R.M. and STRINGER, C.B. 1989. Excavations at Gough's Cave, Somerset 1986-7. *Antiquity*. **63**. 131-136.
- DANIELSON, D.R. and REINHARD, K.J. 1998. Human dental microwear caused by calcium oxalate phytoliths in prehistoric diet of the lower Pecos region, Texas. *American Journal of Physical Anthropology*. **107**. 297-304.
- DANSGAARD, W., WHITE, J.W.C. and JOHNSEN, S.J. 1989. The abrupt termination of the Younger Dryas climate event. *Nature*. **364**. 218-220.

- DAVIES, J.A. 1921. Aveline's Hole, Burrington Combe. An Upper Palaeolithic station. *Proceedings of the University of Bristol Spelaeological Society*. **1**. 61-73.
- DAVIES, J.A. 1922. Second report on Aveline's Hole. *Proceedings of the University of Bristol Spelaeological Society*. **1**. 113-118.
- DAVIES, J.A. 1923. Third report on Aveline's Hole. *Proceedings of the University of Bristol Spelaeological Society*. **2**. 5-15.
- DAVIES, J.A. 1925. Fourth report on Aveline's Hole. *Proceedings of the University of Bristol Spelaeological Society*. **2**. 104-114.
- DAWKINS, W.B. 1864. On the caverns of Burrington Combe. *Somerset Archaeology and Natural History Society Proceedings*. **12**. 161-176.
- DENIRO, M.J. 1985. Post-Mortem Preservation and Alteration of *in vivo* Bone Collagen Isotope Ratios in Relation to Palaeodietary Reconstruction. *Nature*. **317**. 806-809.
- DENIRO, M.J. and EPSTEIN, S. 1981. Influence of diet on the distribution of nitrogen isotopes in animals. *Geochimica et Cosmochimica Acta*. **45**. 341-351.
- DONOVAN, D.T. 1968. The ammonites and other fossils from Aveline's Hole (Burrington Combe, Somerset). *Proceedings of the University of Bristol Spelaeological Society*. **11**. 237-242.
- DRUCKER, D., BOCHERENS, H. and BILLIOU, D. 2003. Evidence for shifting environmental conditions in Southwestern France from 33,000 to 15,000 years ago derived from carbon-13 and nitrogen-15 natural abundances in collagen of large herbivores. *Earth and Planetary Science Letters*. **216**. 163-173.
- DUCROCQ, T., LE GOFF, I. and VALENTIN, F. 1996. La sépulture secondaire Mésolithique de la Chaussée-Tirancourt (Somme). *Bulletin de la Société Préhistorique Française*. **93**. 211-216.
- DUFOUR, E., BOCHERENS, H. and MARIOTTI, A. 1999. Palaeodietary implications of isotopic variability in Eurasian lacustrine fish. *Journal of Archaeological Science*. **26**. 617-627.
- ESKRIGGE, R.A. 1880. Notes on human skeletons and traces of human workmanship found in a cave at Llandudno. *Proceedings of the Liverpool Geological Society*. **4**. 153-155.
- FAIRBANKS, R.G. 1989. A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation. *Nature*. **342**. 637-642.
- FAWCETT, E. 1920. Report on the material found at "The Cave", Burrington. *Proceedings of the University of Bristol Spelaeological Society*. **1**. 5-8.
- FAWCETT, E. 1922. Further report on the human material found in Aveline's Hole. *Proceedings of the University of Bristol Spelaeological Society*. **1**. 79-82.
- FAWCETT, E. 1925. Note on a human mandible from Aveline's Hole. *Proceedings of the University of Bristol Spelaeological Society*. **2**. 120.
- FISCHER, A. 1982. Trade in Danubian shaft-hole axes and the introduction of Neolithic economy in Denmark. *Journal of Danish Archaeology*. **1**. 7-12.

- FLEMMING, N.C. 1982. Multiple regression analysis of earth movements and eustatic sea-level change in the United Kingdom in the past 9000 Years. *Proceedings of the Geological Association*. **93**. 113-125.
- FORMICOLA, V. 1988. Interproximal grooving of teeth: additional evidence and interpretation. *Current Anthropology*. **29**. 663-671.
- FORMICOLA, V. and GIANNECCHINI, M. 1999. Evolutionary trends of stature in Upper Paleolithic and Mesolithic Europe. *Journal of Human Evolution*. **36**. 319-333.
- FRAYER, D.W. 1978. *The Evolution of Dentition in Upper Paleolithic and Mesolithic Europe*, Lawrence. University of Kansas Publications in Anthropology, No. 10.
- FRAYER, D.W. 1980. Sexual dimorphism and cultural evolution in the Late Pleistocene and Holocene of Europe. *Journal of Human Evolution*. **9**. 399-415.
- FRAYER, D.W. 1988. Auditory exostoses and evidence for fishing at Vlasac. *Current Anthropology*. **29**. 346-349.
- FRAYER, D.W. 1991. On the etiology of interproximal grooves. *American Journal of Physical Anthropology*. **85**. 299-305.
- FRAYER, D.W. and FOX, C.L. 1997. Non-dietary marks in the anterior dentition of the Krapina Neanderthals. *International Journal of Osteoarchaeology*. **7**. 133-149.
- GARDINER, J. 2001. The Mesolithic-Neolithic Transition in South-West England. Unpublished PhD thesis, Department of Archaeology and Anthropology, University of Bristol.
- GELFAND, A.E. and SMITH, A.F.M. 1990. Sampling approaches to calculating marginal densities. *Journal of the American Statistical Association*. **85**. 398-409.
- GIBBES, G.S. 1800. Account of a cavern discovered on the north-west side of the Mendip Hills in Somersetshire. *Transactions of the Linnean Society*. **5**. 143-144.
- GILKS, W.R., RICHARDSON, S. and SPIEGELHALTHER, D.J. 1996. *Markov Chain Monte Carlo in Practice*, London. Chapman and Hall.
- GILLESPIE, R., GOWLETT, J.A.J., HALL, E.T., HEDGES, R.E.M. and PERRY, C. 1985. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 2. *Archaeometry*. **27**. 237-246.
- GILLIESON, D. 1996. *Caves: Processes, Development, Management*, Oxford. Blackwell.
- GODWIN, H. 1975. *History of the British Flora: A Practical Basis for Phytogeography*, Cambridge. Cambridge University Press.
- GOLDSTEIN, L.G. 1981. One-dimensional archaeology and multi-dimensional people: spatial organisation and mortuary analysis, pp53-69 in R. Chapman, I. Kinnes and K. Randsborg (eds.), *The Archaeology of Death*, Cambridge. Cambridge University Press.
- GOODMAN, A.H., MARTIN, D.L., ARMELAGOS, G.J. and CLARK, G. 1984. Indications of stress from bones and teeth, pp13-48 in M.N. Cohen and G.J. Armelagos (eds.), *Paleopathology at the Origins of Agriculture*, New York. Academic Press.

- GOODMAN, A.H. and ROSE, J.C. 1991. Dental enamel hypoplasia as indicators of nutritional status, pp279-293 in A. Kelley and C.S. Larsen (eds.), *Advances in Dental Anthropology*, New York. Wiley-Liss.
- GORDON, K.D. 1988. A review of methodology and quantification in dental microwear analysis. *Scanning Microscopy*. **2**. 1139-1147.
- GOWLETT, J.A.J., HEDGES, R.E.M., LAW, I.A. and PERRY, C. 1986. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 4. *Archaeometry*. **28**. 206-221.
- GRINSELL, L.V. 1971. The past and future of archaeology in Somerset. *Proceedings of the Somerset Archaeological and Natural History Society*. **115**. 29-38.
- GRINSELL, L.V. 1985. Carrying flint cores to Mendip. *Lithics*. **6**. 15-17.
- GROLLEAU-RAOUX, J.-L., CRUBÉZY, E., ROUGÉ, D., BRUGNE, J.-F. and SAUNDERS, S.R. 1997. Harris lines: A study of age-associated bias in counting and interpretation. *American Journal of Physical Anthropology*. **103**. 209-217.
- GÜGEL, I.L., GRUPE, G. and KUNZELMANN, K.-H. 2001. Simulation of dental microwear: characteristic traces by opal phytoliths give clues to ancient human dietary behaviour. *American Journal of Physical Anthropology*. **114**.
- HAILE, J. 1996. Aveline's Hole: a reconstruction of Mesolithic diet through the examination of dental health. Unpublished BA Dissertation, Department of Archaeology and Anthropology, University of Oxford.
- HARRIS, H. 1931. Lines of arrested growth in the long bones in children, correlation of histological and radiological appearances in clinical and experimental conditions. *British Journal of Radiology*. **4**. 561-588.
- HAWKEY, D.E. 2003. Human dental remains from Gough's Cave (Somerset, England). *Bulletin of the Natural History Museum of London (Geology)*. **58** (Supplement). 23-35.
- HAWKEY, D.E. and MERBS, C.F. 1995. Activity-induced musculoskeletal stress markers (MSM) and subsistence strategy changes among ancient Hudson Bay Eskimos. *International Journal of Osteoarchaeology*. **5**. 324-338.
- HAWKINS, A.B. 1971. The Late Weichselian and Flandrian transgression of south west Britain. *Quaternaria*. **14**. 115-130.
- HEDGES, R.E.M., HOUSLEY, R.A., LAW, I.A. and BRONK RAMSEY, C. 1989. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 9. *Archaeometry*. **31**. 207-234.
- HEDGES, R.E.M., HOUSLEY, R.A., LAW, I.A. and PERRY, C. 1988. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 7. *Archaeometry*. **30**. 155-164.
- HEDGES, R.E.M., HOUSLEY, R.A., LAW, I.A., PERRY, C. and GOWLETT, J.A.J. 1987. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 6. *Archaeometry*. **29**. 289-306.
- HEDGES, R.E.M., PETTITT, P.B., BRONK RAMSEY, C. and VAN KLINKEN, G.J. 1997. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 24. *Archaeometry*. **39**. 247-262.

- HESS, J., BENDER, M.L. and SCHILLING, J.G. 1986. Evolution of the ratio of strontium-87 to strontium-86 in seawater from the Cretaceous to present. *Science*. **231**. 979-984.
- HEYWORTH, A. and KIDSON, C. 1982. Sea-level changes in south west England and Wales. *Proceedings of the Geologist's Association*. **93**. 91-111.
- HILLSON, S. 1996. *Dental Anthropology*, Cambridge. Cambridge University Press.
- HINTON, M.A.C. 1921. Note on the remains of small mammals obtained from Aveline's Hole, Burrington Combe, Somerset. *Proceedings of the University of Bristol Speleological Society*. **1**. 74-78.
- HINTON, M.A.C. 1923. Note on the rodent remains from Aveline's Hole. *Proceedings of the University of Bristol Speleological Society*. **2**. 34-37.
- HOLLIDAY, T.W. and CHURCHILL, S. 2003. Gough's Cave 1 (Somerset, England): an assessment of body size and shape. *Bulletin of the Natural History Museum of London (Geology)*. **58** (Supplement). 37-44.
- HOUSLEY, R.A. 1991. AMS dates from the Late Glacial and Early Postglacial in north-west Europe: a review, pp25-39 in N. Barton, A.J. Roberts and D.A. Roe (eds.), *The Late Glacial in North-West Europe*, London. Council for British Archaeology, CBA Research Report 77.
- HUMMERT, J. and VAN GERVEN, D. 1985. Observation on the formation and persistence of radioopaque transverse lines. *American Journal of Physical Anthropology*. **66**. 297-306.
- HUSS-ASHMORE, R., GOODMAN, A.H. and ARMELAGOS, G.J. 1982. Nutritional inference from palaeopathology, pp395-474 in M.B. Schiffer (ed.), *Advances in Archaeological Method and Theory*, New York. Academic Press.
- IACUMIN, P., BOCHERENS, H., DELGADO HUERTAS, A., MARIOTTI, A. and LONGINELLI, A. 1997. A stable isotope study of fossil mammal remains from the Paglicci cave, Southern Italy. N and C as palaeoenvironmental indicators. *Earth and Planetary Science Letters*. **148**. 349-357.
- JACOBI, R.M. 1982. Ice Age cave-dwellers: 12000-9000 BC, pp11-13 in M. Aston and I. Burrow (eds.), *The Archaeology of Somerset*, Bridgwater. Somerset County Council.
- JACOBI, R.M. 1987. Misanthropie miscellany: musings on British Early Flandrian archaeology and other flights of fancy, pp163-168 in P. Rowley-Conwy, M. Zvelebil and H.P. Blankholm (eds.), *Mesolithic Northwest Europe: Recent Trends*, Sheffield. University of Sheffield Press.
- JACOBI, R.M. 1997. The "Creswellian" in Britain, pp499-505 in J.-P. Fagnart and A. Thévenin (eds.), *Le Tardiglaciaire en Europe du Nord-Ouest*, Paris. CHTS.
- JACOBI, R.M. 2004. The Late Upper Palaeolithic lithic collection from Gough's Cave, Cheddar, Somerset and human use of the cave. *Proceedings of the Prehistoric Society*. **70**. 1-92.
- JACOBI, R.M. 2005. Some observations on the lithic artefacts from Aveline's Hole, Burrington Combe, North Somerset. *Proceedings of the University of Bristol Speleological Society*.
- JOCHIM, M.A. 1979. "Catches and caches": ethnographic alternatives for prehistory, pp219-246 in C. Kramer (ed.), *Ethnoarchaeology*, New York. Columbia University Press.

- KARKANAS, P., BAR-YOSEF, O., GOLDBERG, P. and WEINER, S. 2000. Diagenesis in prehistoric caves: the use of minerals that form *in situ* to assess the completeness of the archaeological record. *Journal of Archaeological Science*. **27**. 915-929.
- KATZENBERG, M.A. and WEBER, A. 1999. Stable isotope ecology and palaeodiet in the Lake Baikal region of Siberia. *Journal of Archaeological Science*. **26**. 651-659.
- KEITH, A. 1924. Description of three human crania from Aveline's Hole. *Proceedings of the University of Bristol Speleological Society*. **2**. 16-31.
- KENNARD, A.S. and WOODWARD, B.B. 1923. Report on the non-marine mollusca from Aveline's Hole, Burrington Coombe. *Proceedings of the University of Bristol Speleological Society*. **2**. 32-33.
- KENNEDY, G. 1986. The relationship between auditory exostoses and cold water: a latitudinal analysis. *American Journal of Physical Anthropology*. **71**. 401-415.
- KENNEDY, K.A.R. 1983. Morphological variations in ulnar supinator crests and fossae, as identifying markers of occupational stress. *Journal of Forensic Sciences*. **28**. 871-876.
- KIESER, J.A., DENNISON, K.J., KAIDONIS, J.A., D., H., HERBISON, P.G.P. and TAYLES, N.G. 2001. Patterns of dental wear in the early Maori dentition. *International Journal of Osteoarchaeology*. **11**. 206-217.
- KING, T., ANDREWS, P. and BOZ, B. 1999. Effect of taphonomic processes on dental microwear. *American Journal of Physical Anthropology*. **108**. 359-373.
- LARSEN, C.S. 1985. Dental modifications and tool use in the western Great Basin. *American Journal of Physical Anthropology*. **67**. 393-402.
- LARSEN, C.S. 1997. *Bioarchaeology: Interpreting Behavior from the Human Skeleton*, Cambridge. Cambridge University Press.
- LARSSON, L. 1984. The Skateholm Project: a Late Mesolithic settlement and cemetery complex at a southern Sweden bay. *Meddelanden från Lunds Universitets Historiska Museum 1983-1984*. (N.S.) **5**. 5-38.
- LEWIS, J. 2000. Upwards at 45 degrees: the use of vertical caves during the Neolithic and Early Bronze Age on Mendip, Somerset. *Capra*. **2**. <http://www.shef.ac.uk/~capra/2/upwards.html>
- LIEVERSE, A.R. 1999. Diet and the aetiology of dental calculus. *International Journal of Osteoarchaeology*. **9**. 219-232.
- LILLIE, M.C. 2004. Fighting for your life? Violence at the Late-Glacial to Holocene transition in Ukraine, pp89-96 in M. Roksandic (ed.), *Violent Interactions in the Mesolithic*, Oxford. British Archaeological Reports, International Series 1237.
- LILLIE, M.C. and RICHARDS, M. 2000. Stable isotope analysis and dental evidence of diet at the Mesolithic-Neolithic transition in Ukraine. *Journal of Archaeological Science*. **27**. 965-972.
- LISTER, A.M. 1987. Giant deer and giant red deer from Kent's cavern, and the status of *Strongyloceros spelaeus* Owen. *Transactions and Proceedings of the Torquay Natural History Society*. **19**. 189-198.

- LOWE, J.J., COOPE, G.R., LEMDAHL, G. and WALKER, M.J.C. 1995. The Younger Dryas climate signal in land records from N.W. Europe, pp3-26 in S.R. Troelstra, J.E. van Hinte and G.M. Ganssen (eds.), *The Younger Dryas*, Amsterdam. Koninklijke Nederlandse Akademie van Wetenschappen.
- MAAS, M.C. 1994. A scanning electron-microscopic study of *in vitro* abrasion of mammalian tooth enamel under compressive loads. *Archives of Oral Biology*. **39**. 1-11.
- MACPHAIL, R.I. and GOLDBERG, P. 1999. The soil micromorphological investigation of Westbury Cave, pp59-86 in P. Andrews, J. Cook, A. Currant and C. Stringer (eds.), *Westbury Cave. The Natural History Museum Excavations 1976-1984*, Bristol. CHERUB (Centre for Human Evolutionary Research at the University of Bristol).
- MACPHAIL, R.I. and GOLDBERG, P. 2003. Gough's Cave, Cheddar, Somerset: microstratigraphy of the Late Pleistocene/earliest Holocene sediments. *Bulletin of Natural History Museum London (Geology)*. **58** (supplement). 51-58.
- McLAUGHLIN, T.R. 2004. Crunching Numbers: dental microwear and dietary reconstruction at Aveline's Hole, Belas Knap and Téviec. Unpublished BSc dissertation, School of Archaeology and Palaeoecology, Queen's University Belfast.
- MEIKLEJOHN, C., SCHENTAG, C.T., VENEMA, A. and KEY, P. 1984. Socioeconomic change and patterns of pathology and variation in the Mesolithic and Neolithic of western Europe: some suggestions, pp75-100 in M.N. Cohen and G.J. Armelagos (eds.), *Palaeopathology at the Origins of Agriculture*, Orlando. Academic Press.
- MEIKLEJOHN, C. and ZVELEBIL, M. 1991. Health status of European populations at the agricultural transition and the implications for the adoption of farming, pp129-143 in H. Bush and M. Zvelebil (eds.), *Health in Past Societies*, Oxford. BAR International Series 567.
- MILES, A. 1963. Dentition in the estimation of age. *Journal of Dental Research*. **42**. 255-263.
- MILNER, G. and LARSEN, C.S. 1991. Teeth as artifacts of human behavior: intentional mutilation and accidental modification, pp357-378 in A. Kelley and C.S. Larsen (eds.), *Advances in Dental Anthropology*, New York. Wiley-Liss.
- MINAGAWA, M. and WADA, E. 1984. Stepwise enrichment of  $^{15}\text{N}$  along food chains: further evidence and the relation between  $\delta^{15}\text{N}$  and animal age. *Geochimica et Cosmochimica Acta*. **48**. 1135-1140.
- MOLLESON, T. 1985/6. New radiocarbon dates for the occupation of Kilgreany Cave, County Waterford. *Journal of Irish Archaeology*. **3**. 1-3.
- MOLLESON, T. 1989. Seed preparation in the Mesolithic: the osteological evidence. *Antiquity*. **63**. 356-362.
- MOLLESON, T. 1994. The eloquent bones of Abu Hureya. *Scientific American*. **271**. 60-65.
- MOLLESON, T. and JONES, K. 1991. Dental evidence for dietary change at Abu Hureyra. *Journal of Archaeological Science*. **18**. 525-539.
- MOLNAR, S. 1972. Tooth wear and culture: a survey of tooth functions among some prehistoric populations. *Current Anthropology*. **13**. 511-526.



- MONTGOMERY, J., BUDD, P. and EVANS, J. 2000. Reconstructing the lifetime movements of ancient people: a Neolithic case study from southern England. *European Journal of Archaeology*. **3**. 370-385.
- MOOK, W.G. 1986. Business meeting: recommendations/resolutions adopted by the Twelfth International Radiocarbon Conference. *Radiocarbon*. **28**. 799.
- MULLAN, G.J. and WILSON, L.J. 2004. A possible Mesolithic engraving in Aveline's Hole, Burrington Combe, north Somerset. *Proceedings of the University of Bristol Speleological Society*. **23**. 2. 75-85.
- NEWELL, R.R., CONSTANDSE-WESTERMANN, T.S. and MEIKLEJOHN, C. 1979. The skeletal remains of Mesolithic man in western Europe: an evaluative catalogue. *Journal of Human Evolution*. **8**. 1-228.
- NEWTON, E.T. 1921. Note on remains of birds from Aveline's Hole, Burrington Combe, Somerset. *Proceedings of the University of Bristol Speleological Society*. **1**. 73.
- NEWTON, E.T. 1922. List of avian species identified from Aveline's Hole, Burrington. *Proceedings of the University of Bristol Speleological Society*. **1**. 119-121.
- NEWTON, E.T. 1925. Note on additional species of birds from Aveline's Hole. *Proceedings of the University of Bristol Speleological Society*. **2**. 121.
- NORMAN, C. 1982. Mesolithic hunter-gatherers: 9000-4000 BC, pp15-21 in M. Aston and I. Burrow (eds.), *The Archaeology of Somerset*, Bridgwater. Somerset County Council.
- NORMAN, C. 2001. Mesolithic to Bronze Age activity at Parchey Sand Batch, Chedzoy. *Proceedings of the Somerset Archaeological and Natural History Society*. **145**. 9-38.
- NYSTROM, P. and COX, S. 2003. The use of dental microwear to infer diet and subsistence patterns in past human populations: as case study, pp59-67 in M. Parker Pearson (ed.), *Food, Culture and Identity in the Neolithic and Early Bronze Age*, Oxford. BAR International Series 1117.
- OAKLEY, K.P., CAMPBELL, B.G. and MOLLESON, T. 1971. *Catalogue of Fossil Hominds. Part II: Europe*, London. Trustees of the British Museum (Natural History).
- PALMER, S. 1999. *Culverwell Mesolithic Habitation Site, Isle of Portland, Dorset*, Oxford. Archaeopress, British Archaeological Reports, British Series 287.
- PEDERSEN, P.O. and JAKOBSEN, J. 1989. Teeth and jaws of the Qilakitsoq mummies, pp112-130 in J.P. Hart Hansen and H.C. Gullov (eds.), *The Mummies from Qilakitsoq - Eskimos in the 15th Century*. Meddelelser om Grønland, Man and Society 12.
- PÉQUART, M. and PÉQUART, S.-J. 1954. *Hoëdic, Deuxième Station-Nécropole du Mésolithique Côtier Armoricaïn*, Anvers. De Sikkel.
- PÉQUART, M., PÉQUART, S.-J., BOULE, M. and VALLOIS, H. 1937. *Téviec, Station-Nécropole du Mésolithique du Morbihan*, Paris. Archives de L'Institut de Paléontologie Humaine XVIII.
- PÉREZ-PÉREZ, A., ESPURZ, V., DE CASTRO, J.M.B., DE LUMLEY, M.A. and TURBÓN, D. 2003. Non-occlusal dental microwear variability in a sample of Middle and Late Pleistocene human populations from Europe and the Near East. *Journal of Human Evolution*. **44**. 497-513.

- PIRAZZOLI, P.A. 1991. *World Atlas of Holocene Sea-Level Changes*, Amsterdam. Elsevier.
- POOLE, D.F.G. and TRATMAN, E.K. 1978. Post-mortem changes in human teeth from late Upper Palaeolithic/Mesolithic occupants of an English limestone cave. *Archives of Oral Biology*. **23**. 1115-1120.
- POTEKHINA, I. and TELEGRIN, D. 1995. On the dating of the Ukrainian Mesolithic-Neolithic transition. *Current Anthropology*. **36**. 823-826.
- PRICE, T.D. 1985. Affluent foragers of Mesolithic southern Scandinavia, pp341-360 in T.D. Price and J.A. Brown (eds.), *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity*, New York. Academic Press.
- PRICE, T.D., BENTLEY, R.A., LÜNING, J., GRONENBORN, D. and WAHL, J. 2001. Prehistoric human migration in the *Linearbandkeramik* of central Europe. *Antiquity*. **75**. 593-603.
- PRICE, T.D., JOHNSON, C.M., EZZO, J.A., ERICSON, E. and BURTON, J.H. 1994. Residential mobility in the prehistoric Southwest United States: a preliminary study using strontium isotope analysis. *Journal of Archaeological Science*. **21**. 315-330.
- PRICE, T.D., KNIPPER, C., GRUPE, G. and SMRCKA, V. 2004. Strontium isotopes and prehistoric human migration: The Bell Beaker Period in Central Europe. *European Journal of Archaeology*. **7**. 9-40.
- R DEVELOPMENT CORE TEAM. A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna. Available at <http://www.R-project.org>.
- RADOVANOVIC, I. and VOYTEK, B. 1997. Hunters, fishers or farmers: sedentism, subsistence and social complexity in the Djerap Mesolithic. *Analecta Praehistorica Leidensia*. **29**. 19-31.
- RENFREW, C. 1976. Megaliths, territories and populations, pp198-220 in S.J. De Laet (ed.), *Acculturation and Continuity in Atlantic Europe*, Bruges. De Tempel.
- REZNIKOFF, I. and DAVOIS, M. 1988. La dimension sonore des grottes ornées. *Bulletin de la Société Préhistorique Française*. **85**. 238-246.
- RICHARDS, M.P. 2000. Human consumption of plant foods in the British Neolithic: direct evidence from bone stable isotopes, pp123-135 in A.S. Fairbairn (ed.), *Plants in Neolithic Britain and Beyond*, Oxford. Oxbow.
- RICHARDS, M.P. and HEDGES, R.E.M. 2003. Bone collagen  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of fauna from Northwest Europe reflect palaeoclimatic variation over the last 40,000 years. *Palaeogeography, Palaeoclimatology, Palaeoecology*. **193**. 261-267.
- RICHARDS, M.P., HEDGES, R.E.M., JACOBI, R., CURRENT, A. and STRINGER, C. 2000. Gough's Cave and Sun Hole Cave human stable isotope values indicate a high animal protein diet in the British Upper Palaeolithic. *Journal of Archaeological Science*. **27**. 1-3.
- ROBERTS, C. and COX, M. 2003. *Health and Disease in Britain from Prehistory to the Present Day*, Stroud. Sutton.

- ROGERS, J. 1990. The human skeletal material, pp182-198 in A. Saville (ed.), *Hazleton North: The Excavation of a Neolithic Long Cairn of the Cotswold-Severn Group*, London. Historic Buildings and Monuments Commission for England.
- ROWLEY-CONWY, P. 1998. Cemeteries, seasonality and complexity in the Ertebølle of southern Scandinavia, pp193-202 in M. Zvelebil, R. Dennell and L. Domanska (eds.), *Harvesting the Sea, Farming the Forest: The Emergence of Neolithic Societies in the Baltic Region*, Sheffield. Sheffield Academic Press.
- ROZOY, J.-G. 1998. The (re-) population of northern France between 13,000 and 8000 BP. *Quaternary International*. **49/50**. 69-86.
- RUTTER, J. 1829. *Delineations of the North Western Division of the County of Somerset*, London. J. Rutter.
- SAXE, A.A. 1970. Social Dimensions of Mortuary Practices. Unpublished PhD thesis, Dept. of Anthropology, University of Michigan.
- SCHEUER, L. and BLACK, S. 2000. *Developmental Juvenile Osteology*, London. Academic Press.
- SCHMIDT, C.W. 2001. Dental microwear evidence for a dietary shift between two nonmaize-reliant prehistoric human populations From Indiana. *American Journal of Physical Anthropology* **114**, 139-45. 139-145.
- SCHULTING, R.J. 1996. Antlers, bone pins and flint blades: the Mesolithic cemeteries of Tévéc and Hoëdic, Brittany. *Antiquity*. **70**. 335-350.
- SCHULTING, R.J. 2005. *Excavations on the Gower peninsula, 11-25 September 2004: preliminary report*. Report prepared for the National Trust and the British Academy
- SCHULTING, R.J. and RICHARDS, M.P. 2000. The use of stable isotopes in studies of subsistence and seasonality in the British Mesolithic, pp55-65 in R. Young (ed.), *Mesolithic Lifeways: Current Research from Britain and Ireland*, Leicester. University of Leicester Press.
- SCHULTING, R.J. and RICHARDS, M.P. 2001. Dating women and becoming farmers: new palaeodietary and AMS data from the Breton Mesolithic cemeteries of Tévéc and Hoëdic. *Journal of Anthropological Archaeology*. **20**. 314-344.
- SCHULTING, R.J. and RICHARDS, M.P. 2002. Finding the coastal Mesolithic in southwest Britain: AMS dates and stable isotope results on human remains from Caldey Island, Pembrokeshire, South Wales. *Antiquity*. **76**. 1011-1025.
- SCHULTING, R.J. and WYSOCKI, M. 2002. The Mesolithic human skeletal collection from Aveline's Hole: a preliminary report. *Proceedings of the University of Bristol Spelaeological Society*. **22**. 255-268.
- SCHULZ, P.D. 1977. Task activity and anterior tooth grooving in prehistoric California Indians. *American Journal of Physical Anthropology*. **46**. 87-91.
- SCHWARCZ, H.P. 1991. Some theoretical aspects of isotope paleodiet studies. *Journal of Archaeological Science*. **18**. 261-276.

- SHENNAN, I. 1983. Flandrian and Late Devensian sea-level changes and crustal movements in England and Wales, pp255-283 in D.E. Smith and A.G. Dawson (eds.), *Shorelines and Isostasy*, London. Academic Press.
- SHENNAN, I. and HORTON, B. 2002. Holocene land- and sea-level changes in Great Britain. *Journal of Quaternary Science*. **17**. 511-526.
- SHENNAN, I., LAMBECK, K., FLATHER, R., HORTON, B., MCARTHUR, J., INNES, J., LLOYD, J., RUTHERFORD, M. and WINGFIELD, R. 2000. Modelling western North Sea palaeogeographies and tidal changes during the Holocene, pp299-319 in I. Shennan and J.E. Andrews (eds.), *Holocene Land-Ocean Interaction and Environmental Change around the North Sea*, London. The Geological Society.
- SIEVEKING, G.D.G. 1971. The Kendrick's Cave mandible. *British Museum Quarterly*. **35**. 230-250.
- SKINNER, J. XXXV. Skinner Journals Vol. XXXV, *British Library, Additional manuscripts 33,667*. London.
- SKINNER, J. 1819. Skinner Journals Vol. XXII, *British Library, Additional manuscripts 33,654*. London.
- SKINNER, J. 1820. Skinner Journals Vol. XXIX, *British Library, Additional manuscripts 33,656*. London.
- SKINNER, J. 1824. Journal of Tours in Somerset 1824, *British Library, Additional manuscripts 33,677*. London.
- SMITH, B.H. 1984. Patterns of molar wear in hunter-gatherers and agriculturalists. *American Journal of Physical Anthropology*. **63**. 39-56.
- SMITH, C. 1992a. The population of Late Upper Palaeolithic and Mesolithic Britain. *Proceedings of the Prehistoric Society*. **58**. 37-40.
- SMITH, C. 1992b. *Late Stone Age Hunters of the British Isles*, London. Routledge.
- STEELE, D.G. and BRAMBLETT, C.A. 1988. *The Anatomy and Biology of the Human Skeleton*, College Station. Texas A&M University Press.
- STINER, M.C., KUHN, S.L., SUROVELL, T.A., GOLDBERG, P., MEIGNEN, L., WEINER, S. and BAR-YOSEF, O. 2001. Bone preservation in Hayonim Cave (Israel): a macroscopic and mineralogical study. *Journal of Archaeological Science*. **28**. 643-659.
- STUART-MACADAM, P. 1992. Anaemia in past human populations, pp151-170 in P. Stuart-Macadam and S.K. Kent (eds.), *Diet, Demography and Disease. Changing Perspectives on Anaemia*, New York. Aldine de Gruyter.
- STUIVER, M. and KRA, R.S. 1986. Editorial comment. *Radiocarbon*. **28**. ii.
- STUIVER, M. and POLACH, H.A. 1977. Reporting of <sup>14</sup>C data. *Radiocarbon*. **19**. 355-363.
- STUIVER, M. and REIMER, P.J. 1986. A computer program for radiocarbon age calculation. *Radiocarbon*. **28**. 1022-1030.

- STUIVER, M. and REIMER, P.J. 1993. Extended  $^{14}\text{C}$  data base and revised CALIB 3.0  $^{14}\text{C}$  age calibration program. *Radiocarbon*. **35**. 215-230.
- STUIVER, M., REIMER, P.J., BARD, E., BECK, J.W., BURR, G.S., HUGHEN, K.A., KROMER, B., MCCORMAC, G., VAN DER PLICHT, J. and SPURK, M. 1998. INTCAL98 radiocarbon age calibration, 24,000-0 cal BP. *Radiocarbon*. **40**. 1041-1083.
- TEAFORD, M.F. 1988. Scanning electron microscope diagnosis of wear patterns versus artifacts on fossil teeth. *Scanning Microscopy*. **2**. 1167-1175.
- TEAFORD, M.F. 1991. Dental microwear: what can it tell us about diet and dental function?, pp342-356 in A. Kelley and C.S. Larsen (eds.), *Advances in Dental Anthropology*, New York. Wiley-Liss.
- TEAFORD, M.F. and LYTLE, J.D. 1996. Diet-induced changes in rates of human tooth microwear: a case study Involving stone-ground maize. *American Journal of Physical Anthropology*. **100**. 143-147.
- TEAFORD, M.F. and WALKER, A. 1984. Quantitative differences in dental microwear between primate species with different diets, and comment on the presumed diet of Sivapithecus. *American Journal of Physical Anthropology*. **64**. 191-200.
- TEIT, J.A. 1900. The Thompson Indians of British Columbia, pp163-392, *Memoirs of the American Museum of Natural History*, New York.
- TRATMAN, E.K. 1922. Notes on the human teeth obtained from Aveline's Hole, Burrington Combe, Somerset. *Proceedings of the University of Bristol Spelaeological Society*. **1**. 122-125.
- TRATMAN, E.K. 1923. Further notes on the human teeth from Aveline's Hole, Burrington Combe. *Proceedings of the University of Bristol Spelaeological Society*. **2**. 38.
- TRATMAN, E.K. 1975a. The cave archaeology and palaeontology of Mendip, pp352-403 in D.I. Smith (ed.), *Limestones and Caves of the Mendip Hills*, Newton Abbott. David & Charles.
- TRATMAN, E.K. 1975b. *Aveline's Hole, Burrington Combe. A summary account*, Unpublished manuscript held in University of Bristol Spelaeological Society Library.
- TRATMAN, E.K. 1977. A further radiocarbon date on human bone material from Aveline's Hole, Burrington Combe, Mendip. *Proceedings of the University of Bristol Spelaeological Society*. **14**. 261-262.
- TRINKAUS, E. 2001. Gough's Cave 1 (Somerset, England): a study of the hand bones. *Bulletin of the Natural History Museum of London (Geology)*. **57**. 25-28.
- TRINKAUS, E. 2003. Gough's Cave 1 (Somerset, England): a study of the pelvis and lower limbs. *Bulletin of the Natural History Museum of London (Geology)*. **58** (Supplement). 1-21.
- UBELAKER, D.H. 1978. *Human Skeletal Remains: Excavation, Analysis, Interpretation*, Chicago. Aldine.
- UNGAR, P.S. 2002. Microware software, Version 4.02. A semi-automated image analysis system for the quantification of dental microwear. Fayetteville, AR USA.

- UNGAR, P.S., BROWN, C.A., BERGSTROM, T.S. and WALKER, A. 2003. Quantification of dental microwear by tandem scanning microscopy and scale-sensitive fractal analyses. *Scanning*. **25**. 185-193.
- UNGAR, P.S. and SPENCER, M.A. 1999. Incisor microwear, diet, and tooth use in three Amerindian populations. *American Journal of Physical Anthropology*. **109**. 387-396.
- VAN DER PLICHT, J., WIJMA, S., AERTS, A.T., PERTUISOT, M.H. and MELJER, H.A.J. 2000. Status report: the Groningen AMS facility. *Nuclear Instruments and Methods in Physics Research B*. **172**. 58-65.
- VANDERKLIFT, M.A. and PONSARD, S. 2003. Sources of variation in consumer-diet  $\delta^{15}\text{N}$  enrichment: a meta-analysis. *Oecologia*. **136**. 169-182.
- VOGEL, J.C. and WATERBOLK, H.T. 1972. Groningen radiocarbon dates X. *Radiocarbon*. **14**. 6-110.
- VON DEN DRIESCH, A. 1976. *A Guide to the Measurement of Animal Bones from Archaeological Sites*, Harvard. Peabody Museum Bulletin.
- VYHNANEK, L. and STLOUKAL, M. 1988. Harris' lines in adults: an open problem, pp92-94 in D.J. Ortner and A.C. Aufderheide (eds.), *Human Paleopathology*, Washington, D.C. Smithsonian Institution Press.
- WADDINGTON, C. (ed.) In press. *Mesolithic Settlement in the North Sea Basin: A Case Study from Howick, North-East England*, Oxford. Oxbow and English Heritage.
- WADDINGTON, C., BAILEY, G., BAYLISS, A., BOOMER, I., MILNER, N., PEDERSEN, K., SHIEL, R. and STEVENSON, A. 2003. A Mesolithic settlement site at Howick, Northumberland: a preliminary report. *Archaeologia Aeliana*. **32** (5<sup>th</sup> series). 1-12.
- WAINWRIGHT, G.J. 1960. Three microlithic industries from south-west England and their affinities. *Proceedings of the Prehistoric Society*. **26**. 193-201.
- WANSEY, H. 1805. Untitled letter to the editor. *The Gentleman's Magazine*. **75**. 409.
- WEISS, K.M. 1973. Demographic Models for Anthropology. *Memoirs of the Society for American Archaeology*. **27**.
- WILLEY, P. and HOFMAN, J.L. 1994. Interproximal grooves, toothaches, and purple cornflowers, pp147-157 in D.W. Owsley and R. Jantz (eds.), *The Skeletal Biology of the Plains*, Washington, D.C. Smithsonian Institution Press.
- WILLIAMS, R.G.J. 1999. Membership of the Bristol Speleological Research Society 1912-1919. *Proceedings of the Bristol Speleological Society*. **21**. 215-234.
- WYSOCKI, M. and WHITTLE, A. 2000. Diversity, lifestyles and rites: new biological and archaeological evidence from British earlier Neolithic mortuary assemblages. *Antiquity*. **74**. 591-601.
- YALDEN, D. 1999. *The History of British Mammals*, London. T & A D Poyser.
- ZVELEBIL, M. 1994. Plant use in the Mesolithic and its role in the transition to farming. *Proceedings of the Prehistoric Society*. **60**. 35-74.

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