Dinnis, R, Bates, MR, Bello, SM, Buck, LT, Davies, JS, Preece, RC, Walker, EA, Boulton, J, Flas, D, Harris, S-J, Mogg, J and Schouten, R

Archaeological collections from Long Hole (Gower, Swansea, UK) and their place in the British Palaeolithic

Cave and Karst Science, Vol.46, No.1, (2019) 37–46
Transactions of the British Cave Research Association

ISSN 1356-191X

Archaeological collections from Long Hole (Gower, Swansea, UK) and their place in the British Palaeolithic

Rob DINNIS[(1)], Martin R BATES, Silvia M BELLO, Laura T BUCK, Jesse S DAVIES, Richard C PREECE, Elizabeth A WALKER, John BOULTON, Damien FLAS, Sarah-Jayne HARRIS, Jonquil MOGG and Remmert SCHOUTEN

[(1)] Correspondence address:
British Museum (Britain, Europe and Prehistory), Franks House, 56 Orsman Road, London, N1 5QL, UK.
e-mail: rdinnis@britishmuseum.org

Abstract: At the time of its excavation in 1861, the cave site of Long Hole (Gower peninsula, Swansea, UK) was recognized as important for establishing the antiquity of man in Wales. However, in comparison to its more illustrious neighbour Paviland Cave, it has received very little attention since. Long Hole has been host to three documented excavations: by Colonel Wood in the 1860s, by John Campbell in 1969 and most recently the small-scale work in 2012 described in this paper. Here we outline Long Hole's excavations and the archaeological material from the cave. Although the site's earliest collections suffer from the familiar problems of being significantly selected and lacking contextual information, several conclusions are possible. Previous suggestions of two late Neanderthal occupations are unconvincing. Lithic artefacts from Long Hole are instead reminiscent of Aurignacian material from Paviland Cave, suggesting that they were left by some of Britain's very early modern human occupants, 37–35,000 cal BP. Because Campbell excavated an apparently well-stratified Late Pleistocene sequence his collections have the greatest potential for future work.

Received: 06 February 2019; *Accepted*: 07 March 2019.

Late Neanderthals and early modern humans in Britain

Between 60,000 and 30,000 years ago, during the Late Pleistocene, Britain saw several periods of occupation by late Neanderthals and early modern humans (i.e. *Homo sapiens*) (Pettitt and White, 2012; Dinnis and Stringer, 2014) (Fig.1). Both lived in relatively small and mobile groups, exploiting reindeer, wild horse and bison as part of their hunter-gatherer existence. Prior to the full glacial conditions of the Late Devensian, the Middle Devensian environments in Britain, in which Neanderthals and modern humans lived, were relatively productive. Evidence points to landscapes dominated by open steppic grasslands, with sedges, herbaceous plants and dwarf trees, which at least sometimes supported substantial populations of large mammals (Currant and Jacobi, 2011; Schreve *et al*., 2013; Dinnis *et al*., 2016) (Fig.1). Notably this included hyaenas, which commonly denned in caves and accumulated much of the animal bone found at British sites of this period (Aldhouse-Green *et al*., 1995; Turner, 2000; Currant and Jacobi, 2011).

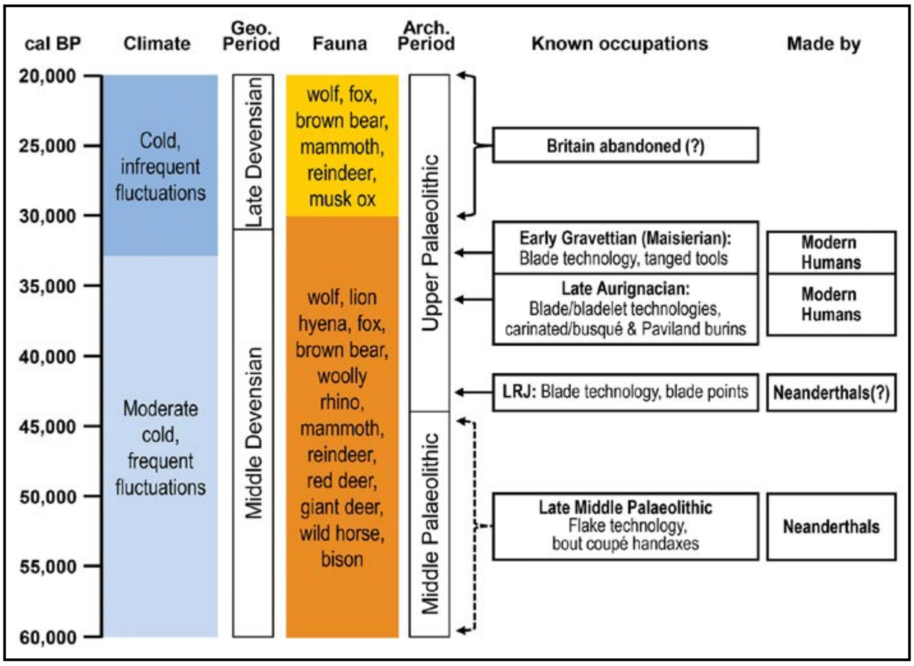

Figure 1: Known archaeological occupations of Britain, 60–20,000 cal BP, shown alongside major changes in climate and large mammal fauna. The dashed line for Late Middle Palaeolithic denotes uncertainty about when in this period occupation(s) occurred. Note "LRJ" refers to the "Lincombian–Ranisian–Jerzmanowician" (Flas, 2008). Figure compiled from information in Jacobi (2007); Flas (2008); Jacobi et al. (2010); Currant and Jacobi (2011); Jacobi and Higham (2011); Pettitt and White (2012); Cooper et al. (2012); Dinnis (2012a); Pesesse and Flas (2012); Dinnis et al. (2016) and Touzé (2018).

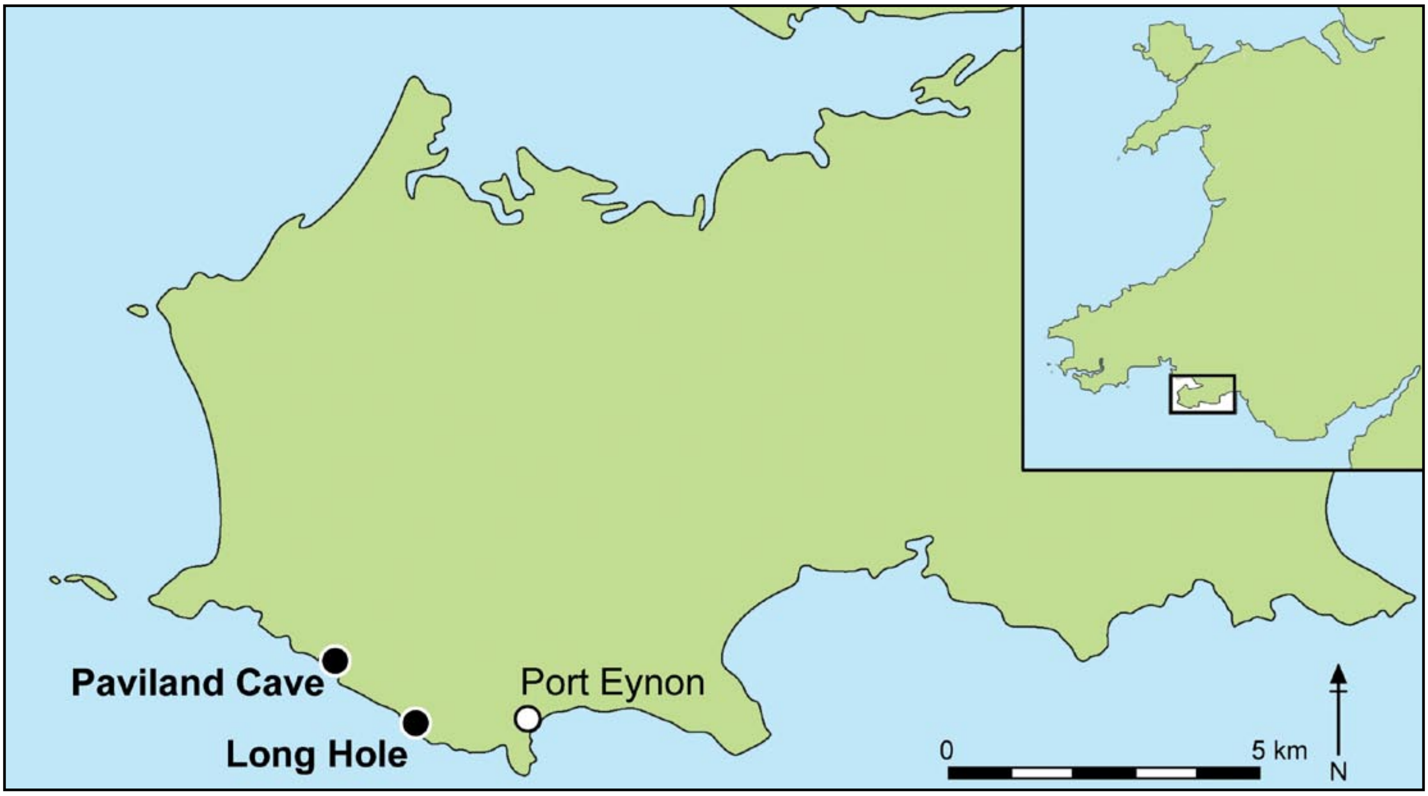

Figure 2: *Location of Long Hole and Paviland Cave on the south Gower coast. (Figure: C Williams.)*

Despite these sometimes-favourable conditions, however, it appears that humans only occupied Britain sporadically and peripherally relative to their more continuous presence farther south (Jacobi, 1999; Jacobi and Higham, 2011; Dinnis, 2012a; Pettitt and White, 2012). This was probably in part due to the numerous millennial/centennial climatic oscillations during the period (Voelker, 2002; Rasmussen *et al*., 2014). Although the British palaeoenvironmental record is insufficient to document these fluctuations, we can surmise from evidence elsewhere in Europe that these climatic changes will have had a profound impact on plant and animal communities throughout the Devensian (Sánchez Goñi *et al*., 2008; Haesaerts, *et al*., 2009).

Evidence for late Neanderthal and early modern human occupations comes mostly from caves, primarily in the form of characteristic stone tools (Fig.1), along with a handful of cutmarked or worked bone/antler artefacts and human skeletal remains from Kents Cavern and Paviland Cave. Unfortunately, Britain's most important Palaeolithic caves were largely or wholly dug out in the 19th or early 20th centuries, when archaeology as a scientific endeavour was still in its infancy. These excavations did not meet modern standards, and for many sites there is scant, if any, stratigraphical information accompanying archaeological and palaeontological finds. Since then, however, archaeologists have gleaned further information from this material by applying newly developed methods of analysis (Aldhouse-Green, 2000a; Jacobi, 2007; Jacobi and Higham, 2008; Dinnis, 2012a). In addition, new small-scale excavations at sites dug previously have sought better to contextualise the material (e.g. McBurney, 1959; Campbell, 1977; Pettitt *et al*., 2009; Aldhouse-Green *et al*., 2012; Dinnis and Proctor, 2015).

2012 excavations – view southwards, showing Trench 1 being opened.

Archaeological and palaeontological material from caves on the Gower peninsula (Swansea, Wales) has played a particularly important role in developing our understanding of Pleistocene Britain. Faunal assemblages from numerous sites, perhaps most notably Bacon Hole and Minchin Hole, are key to reconstructing Middle/Late Pleistocene environmental change (Currant and Jacobi, 2011; Dinnis *et al*., 2016). Archaeological traces of human occupation older than 30,000 cal BP have been found at Long Hole, Cathole and Paviland Cave (Campbell, 1977; Green and Walker, 1991; Aldhouse-Green, 2000a; Jacobi and Higham, 2011; Dinnis, 2012a–c). Paviland Cave is Gower's most well-known Palaeolithic site, and for good reason. Excavated over many periods through the 19th and 20th centuries, the cave's sediments were rich in animal bone and stone tools, many attributable to the Aurignacian or the Lincombian-Ranisian-Jerzmanowician (henceforth LRJ) (Aldhouse-Green, 2000a; Swainston, 2000) (Fig.1). The most notable discovery in the cave was the so-called "Red Lady of Paviland" burial, found in 1823 by William Buckland. The Red Lady skeleton is, in fact, that of a young adult male, most recently radiocarbon dated to 34–33,000 cal BP (Jacobi and Higham, 2008). The burial included perforated winkle shells, worked ivory objects and was stained red with ochre (Aldhouse-Green, 2000a). Along with a fragment of upper jaw bone from Kents Cavern of broadly similar age (Jacobi and Higham, 2011), the Red Lady is the oldest modern human fossil in Britain. When compared to Paviland Cave, Cathole and Long Hole have been the focus of much less research. Although collections from Cathole mostly derive from later periods of hunter-gatherer activity, four fragmentary flint tools are attributable to an occupation around 33–32,000 cal BP (Jacobi *et al*., 2010; Jacobi and Higham, 2011), and recent fieldwork at Cathole has confirmed that occupation by animals goes back to at least 50,000 cal BP (Walker *et al*., 2014). Although Long Hole has long been thought to have contained evidence of similar early occupation, it has seen even less work.

Long Hole: background and archaeological work

Location and geology

Long Hole (SS 45118 85065; also known as Longhole) is located on the south Gower coast, roughly halfway between Port Eynon Point to the east and Paviland Cave to the west (Fig.2). The cave is elevated c.50m above the high-tide line and faces southsoutheast across the Bristol Channel to the north Devon coast beyond. Formed in Carboniferous limestone of the High Tor Formation, the currently exposed length of the cave void is c.15m (Fig.3).

Although now largely dug out, a few geological observations regarding the cave's sedimentary fill are possible. Fragments of a crystalline stalagmite floor lie above the cave's current floor level. Underneath this throughout the cave are some small patches of limestone gravels. At the back of the cave the stalagmite floor, capping intact clay deposits, rises towards the cave's rear. It is therefore possible that a sinkhole or other passage to the north served as a sediment source for Long Hole, in addition to its main entrance to the south.

2012 excavations – initial screening of deposits.

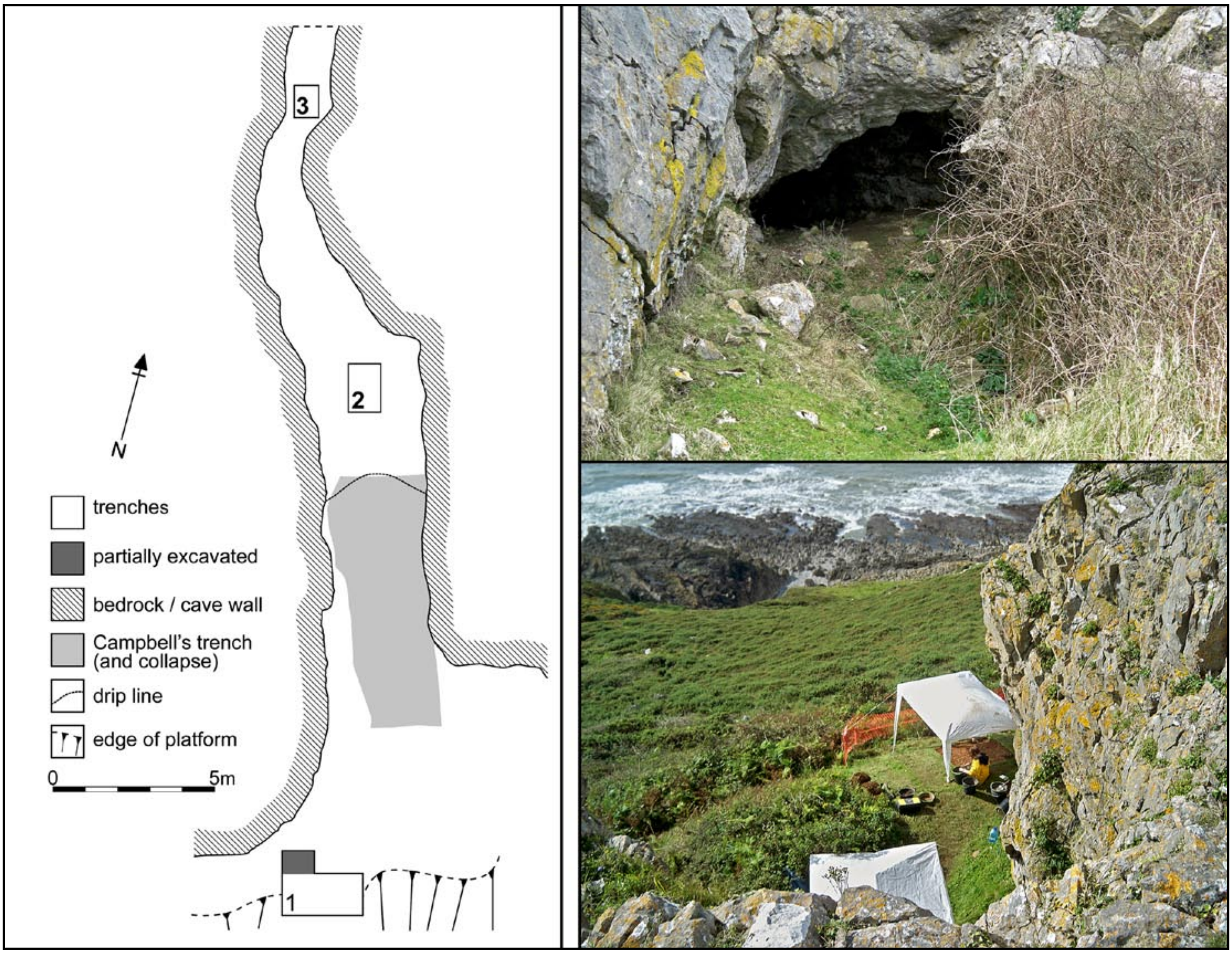

Figure 3: (***Left***) *Plan of Long Hole showing the location of Campbell's 1969 trench on the platform outside the cave and locations of Trenches 1, 2 and 3 from 2012.* (***Right***) *Photographs from the 2012 fieldwork. Top photograph shows the cave's entrance – the depression in front of the cave is the remnants of Campbell's trench. Bottom photograph, taken from above the cave and facing south, shows the early stages of excavation of Trench 1.*

Collection	Museum accession number/ identifier	Provenance	Raw Material	Type	Length (mm)	Width (mm)	Thickness (mm)	Damage?	Notes
Wood (1961) (British Museum)	1916.11-11.9	N/A	Black chert	Laminar flake, notched piece	59	29.5	10		
	1916.11-11.6	N/A	Flint	Flake	33.5	21.5	9		
	1916.11-11.7	N/A	Flint	Laminar fragment	36.5	24	7		
	1916.11-11.2-8	N/A	Flint	Flake	28.5	20	6.5		
	1916.11-11.2-3	N/A	Flint	Carinated burin on crested blade	68.5	18.5	12.5	Edge damage	Illustrated in Dinnis (2012c) and in Garrod (1926: 67, fig. 2, no.10)
	1916.11-11.4	N/A	Flint	Blade	69	13.5	7		
	1916.11-11.5	N/A	Flint	Blade, distal fragment	59.5	13.5	6	Heavy damage	
	1916.11-11.2	N/A	Flint	Bladelet core	30	32	21.5		Illustrated in Garrod (1926: 67, fig. 9, no. 9) and described by her as a "keeled scraper"
Wood (1961) (Swansea Museum)	SM1861.2(?)	N/A	Black chert	Burin, notched piece	56	18	8(?)	Edge damage	Bladelet core?
	SM1861.2(?)	N/A	Black chert	Endscraper, burin	47	18	6(?)		Illustrated in Garrod (1926: 67, fig. 9, no. 8)
	SM1861.2(?)	N/A	Coarse-grained chert	Blade fragment, mesial	38	17	5(?)		
	SM1861.2(?)	N/A	Flint	Flake fragment	43	25	18.5(?)		
	SM1861.2(?)	N/A	Flint	Laminar flake fragment	29	12.5	4.5(?)	Edge damage	
	SM1861.2(?)	N/A	Flint	Blade fragment, mesial	41.5	14	5(?)	Edge damage	
	SM1861.2(?)	N/A	Flint	Crested blade	66	12.5	9.5(?)		On display as from Nottle Tor (27/2/2013)
	SM1861.2(?)	N/A	Flint	Endscraper on laminar flake	63.5	25.5	7.5(?)	Edge damage	On display as from Paviland Cave (27/2/2013)
Campbell (1969) (National Museum of Wales, Cardiff)	2007.49H/6	?	Flint	Retouched blade fragment (mesial)	29	18.5	5	Edge damage	Found at start of excavation (Finds no. 2, finds date 6th August 1969)
	2007.49H/5	Layers A3a/A3b	Black Chert	Spall	5	6	2.5		Not certainly anthropogenic (sediment adhering)
	2007.49H/4	Layers A3a/A3b	Black Chert	Blade fragment (mesial)	27	15.5	4.5	Edge damage	
	2007.49H/3	Layers A3a/A3b	Black Chert	Flake fragment(?)	22.5	10.5	4		Not certainly anthropogenic (sediment adhering)
	2007.49H/1	Layers A3a/A3b	Flint	Flake fragment	18	15	1.5		
	2007.49H/2	Layers A3a/A3b	Flint	Flake fragment	28.5	25	3		
Dinnis (2012)	LH12 1	Trench 2, Campbell spoil	Flint	Chip	4.5	3.5	0.5		Not certainly anthropogenic
	LH12 2	Trench 1, 1002, Campbell spoil	Flint	Laminar flake fragment(?)	17	9	4.5		Not certainly anthropogenic
	LH12 3	Trench 1, 1005-1006 boundary	Flint	Flake	13	14.5	3.5		
	LH12 4	Trench 1, 1006	Flint	Laminar flake, distal fragment	21.5	13	4		Edge retouch(?)
	LH12 5	Trench 1, 1006	Flint	Flake	20.5	20.5	2.5		
	LH12 6	Trench 2, Campbell spoil	Flint	Chip	6.5	5	3		
	LH12 7	Trench 1, 1006	Flint	Flake	30	15.5	5	Edge damage	
	LH12 8	Trench 1, 1006	Flint	Fragment	5.5	6	2.5		Not certainly anthropogenic
	LH12 9	Trench 1, 1007	Flint	Fragment	29.5	13	7.5		Not certainly anthropogenic
	LH12 10	Trench 1, 1007	Flint	Fragment	24.5	14.5	4.5		Not certainly anthropogenic
	LH12 11	Trench 1, 1007	Flint	Flake	27	12.5	4	Edge damage	
	LH12 12	Trench 1, 1007	Flint	Flake fragment	12	9	3		
	LH12 13	Trench 1, 1007	Flint(?)	Fragment	10	4	5	Burned	Not certainly anthropogenic
	LH12 14	Trench 1, 1007	Flint	Flake, distal fragment	10.5	9	3		
	LH12 15	Trench 1, 1007	Flint	Laminar flake	19.5	8	2.5		
	LH12 16	Trench 1, 1007	Flint(?)	Fragment	7.5	4.5	3	Burned	Not certainly anthropogenic
	LH12 17	Trench 1, 1007	Flint	Fragment	14.5	7.5	5		Not certainly anthropogenic
	LH12 18	Trench 1, 1007	Flint(?)	Fragment	9	6	2.5	Burned(?)	Not certainly anthropogenic
	LH12 19	Trench 1, 1007	Flint	Flake fragment	33	27.5	3		
	LH12 20	Trench 1, 1007	Flint	Flake fragment	34.5	16.5	8		
	LH12 21	Trench 1, 1007	Flint	Laminar flake, mesial fragment	13.5	15.5	3		
	LH12 22	Trench 1, 1007	Flint	Laminar flake, distal fragment	10.5	8	2.5		
	LH12 23	Trench 1, 1007	Flint	Bladelet, proximal fragment	19.5	9	3		
	LH12 24	Trench 1, 1007	Flint	Flake(?)	46	25.5	10		Not certainly anthropogenic
	LH12 25	Trench 1, 1007	Flint	Fragment	18	19.5	9		Not certainly anthropogenic
	LH12 26	Trench 1, 1007	Flint	Chip	6	5.5	1		Not certainly anthropogenic

***Table 1**: Certain and probable lithic artefacts from Long Hole, from the excavations of Wood (1861), Campbell (1969) and Dinnis (2012). Note that artefacts at Swansea Museum are attached to display boards and therefore cannot be studied fully; thickness measurements for these artefacts should be considered as approximate. Also note that an additional artefact from Wood's campaign not studied by us is listed by Campbell (1977, Vol.2, p.101) as housed at the Pitt Rivers Museum, Oxford. This artefact is probably that figured by Campbell (1977, Vol.2, Fig.97, No.6) (see text).*

Excavation/research history

During the 19th century Lieutenant-Colonel E R Wood, working in collaboration with Hugh Falconer, excavated most of Gower's best-known archaeological caves, including Cathole, Bacon Hole, Minchin Hole, Bosco's Den, Paviland Cave and Long Hole (Lyell, 1863: p.172; Dawkins, 1874: p.288; Falconer, 1868: pp.538–9; Walker *et al*., 2014). Wood was prolific – Lyell (cited in Falconer, 1864: p.249) referred to him as a "zealous explorer" – but the record of his work is frustratingly poor. Most information from his work at Long Hole comes from Falconer (1864; 1868) and some of his contemporaries. Those writing about Wood's work saw Long Hole as the most important site he excavated, because it most convincingly demonstrated the deep antiquity of human occupation of Wales (Lyell, 1863; Falconer, 1864; Dawkins, 1874; Roberts, 1888).

The most detailed account of Wood's work at Long Hole comes from the notes of Falconer (1868), which were published after his death. Wood located the cave in the autumn of 1861 and began work soon after. The cave's sedimentary deposits are described as being around seven-foot-deep and composed of "ferruginous unctuous cave earth" intermixed with large (c. 3.5–4 kg) angular limestone blocks (Falconer, 1868: p.539). Wood found an array of fossils from warm and cold-adapted fauna, including hyaena, lion, bear, rhinoceros, horse, deer and pig/boar. In addition, Wood found several worked flints, with one example noted as being found next to and at the same depth as a rhinoceros molar. Seventeen lithic artefacts from Wood's excavations are known in museum collections (Campbell, 1977, Vol.2, p.101) (Table 1).

Until Dorothy Garrod's (1926) important study of the British Upper Palaeolithic, Wood's lithic collection from Long Hole received little attention, being referred to only as undoubtedly of human handiwork. Garrod (1926: p.69) identified the collection as Upper Palaeolithic and suggested a "Middle or Upper Aurignacian" age. Writing prior to the re-structuring of the Western European Upper Palaeolithic by Peyrony in 1933, and her own further re-ordering of it in 1936 (see Davies, 2001: p.196), Garrod therefore thought the assemblage belonged to a period that today encompasses the Aurignacian and the Mid Upper Palaeolithic/Gravettian. This period, from c.41,000 to c.27,000 cal BP, marks the earliest period of modern human occupation of Europe.

Further excavation at Long Hole was carried out by John Campbell in August and September 1969 (Campbell, 1977). After finding no evidence for intact deposits in the cave's interior, Campbell excavated a large area of its external platform (Campbell, 1977: 59–60; Vol.2, pp.168–169) (Fig.3). In the southern/eastern part of his trench Campbell discovered a 4m-long sequence of intact sediments. Analysis of the sediments and pollen indicated the presence of a major cold phase, which Campbell interpreted as the maximum cold of the last glacial cycle (22,000–19,000 cal BP). In addition to yielding animal bone and some shell, the sequence contained five lithic artefacts (Table 1), found in layers A3a/A3b, towards the base of the stratigraphy and underlying the marked cold phase. In his analysis of the site, Campbell (1977: 145–6) interpreted one of Wood's finds as a fragment of a blade-point[1], and therefore saw evidence for an LRJ occupation (see Figure 1). He also noted a small flint flake from his own excavations, which he suggested might relate to blade-point manufacture, thereby providing a tentative correlation between Wood's collection and his own. Campbell also noted anthropogenic material even lower in his stratigraphy. In layer A2b, underlying A3a/A3b, he records "an apparently struck flake of limestone and a bone tool" (Campbell, 1977: 60). On stratigraphical grounds Campbell concluded that these pre-dated the lithic assemblage he had attributed to the Early Upper Palaeolithic, and therefore were evidence for an additional, earlier Late Middle Palaeolithic occupation (see Figure 1).

[1] *Campbell (1977) refers to these artefacts as "leaf-points", but there is no doubt that he is referring to artefacts that are now thought to characterize the LRJ. Here we follow Jacobi (2007) in using the term "blade-point". This term helps to distinguish these characteristic artefacts made on blades from more generic leaf-points found in several different periods.*

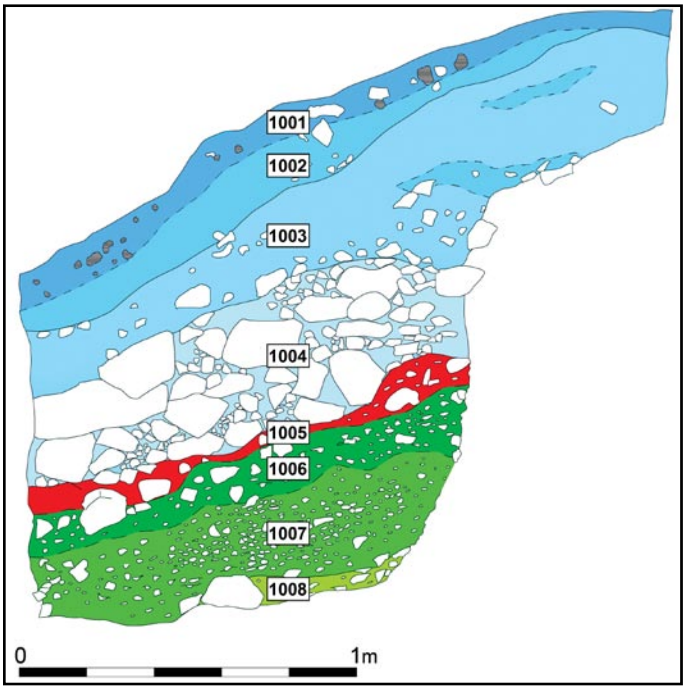

***Figure 4**: East-facing section of Trench 1 (see Table 2 for details). The blue section (Contexts 1001–1004) is spoil left by Campbell, the red layer (Context 1005) is a buried topsoil, and we interpret the underlying green section (Contexts 1006–1008) as Wood's spoil. Context 1009 was not present in this part of the trench. All clasts figured are limestone, except fragments of calcite in Context 1001, which are denoted by shading.*

2012 excavation

New fieldwork at the site was undertaken in August 2012 under the direction of one of us (RD). Excavation of three trenches aimed to test spoil from previous work for missed archaeological objects (Fig.3).

The largest trench (Trench 1) targeted an area of presumed spoil deposits at the end of the cave's platform. The stratigraphy of Trench 1, along with our interpretation of it, are provided in Table 2 and Figure 4. The upper section of Trench 1 (Contexts 1001–1004) was clearly composed of Campbell's spoil, which contained some fragmentary bone material. Campbell's spoil overlay a buried topsoil (Context 1005).

2012 excavations – screening of fine-fraction sediments, and in the process back-filling Campbell's trench.

Context	Deposit	Finds	Interpretation	Notes
1001	Red-orange clay with numerous large calcite blocks (c.3–10cm)	Bone Fragments, microfauna	Spoil from Campbell's layer A2a, which was amongst his basal deposits	Broad inverse stratigraphy of Campbell's trench (see Campbell 1977, Vol.2, fig. 19).
1002	Red-orange clay as 1001, but lacking calcite inclusions. To the west of the excavation area the matrix was much siltier and less clayey than to the east	One fragment of flint (Table 1), bone fragments, fox tooth (left P^4)	Spoil from Campbell's layers A2b and A2c	
1003	Grey silty sands, with some lenses of red-orange clay	Bone fragments	Spoil from Campbell's layer A3a, and perhaps higher levels. Contained some conspicuous lenses of 1002 within (see Fig. 3).	
1004	Layers containing various sizes of limestone blocks, with little or no sedimentary fill	Bone fragments	Spoil from Campbell's scree-heavy levels (C/B to A3b)	
1005	Dark brown/black humic sediment with no clastic inclusions	Terrestrial gastropod (land snail) shells, microfauna, bone fragments, tile fragments	Buried topsoil	Consistent across all sections of the trench.
1006	Sandy silt, more orange-brown than the overlying 1005. Some large limestone inclusions (≥ 10cm)	Five flints (Table 1), terrestrial and marine gastropod shells (Table 3), bone fragments, microfauna, horse tooth (left $M^{2[?]}$)	Wood's spoil, with some mixing with overlying buried topsoil	
1007	Gravel formed mainly of 1–3cm limestone clasts. Matrix of clayey silt of a dark, rich-brown colour, with some redder patches apparent, particularly when the sediment is wet	Eighteen flints (Table 1), marine gastropod shells (Table 3), two horse incisors, cf. red-deer tooth crown (right $P^{3[?]}$), two fragments of late prehistoric pottery, clay pipe stem	Wood's spoil	
1008	Similar to 1007 but more compacted and redder. In some places the boundary between 1007 and 1008 was marked by the presence of large limestone blocks (≥ 20cm)	Few bone fragments	Wood's spoil (?)	
1009	Large limestone blocks (≥ 10cm) with no sedimentary fill	None	Wood's spoil (?)	Only apparent in the easternmost part of excavated area, and seemingly inter-stratified with 1008

Table 2*: Stratigraphical units in Trench 1 following removal of topsoil, from top to bottom. See also Figure 4. Note that the deposits interpreted here as Campbell's spoil and Wood's spoil were distributed unevenly across the trench: a greater depth of Campbell's spoil was evident in the western side of the trench. It is possible that the bulk of Wood's spoil lies to the east of the eastern part of Trench 1 (see Figure 2).*

Underlying Campbell's spoil was a finds-rich unit (Context 1006 and especially Context 1007). In total, 23 flint artefacts and fragments came from this unit (Table 1). Although some are ambiguously anthropogenic, their association with undoubtedly worked flint leads us to suspect that most or all relate to human activity. Also present was fragmentary bone, much of it badly degraded. In addition, this unit contained a large assemblage of marine gastropod shells, including more than 100 complete/near complete periwinkle (*Littorina littorea*) shells (Table 3). Periwinkle shells are common on prehistoric sites, and these were likely introduced to the site for use as food or bait. Radiocarbon dating of one example suggests a late prehistoric age for their accumulation (Table 4), much younger than the Palaeolithic age of other archaeological material from the site. Two small fragments of coarse-matrixed pottery of probable late prehistoric age also attest to later activity at the cave.

One additional shell found in this unit deserves special comment. A *Tritia reticulata* shell with an ancient perforation in its body-whorl (Fig.5), bears some similarity to shell beads known from archaeological sites elsewhere. Two factors suggest that this too may be a deliberately perforated shell bead. First, shells with only one perforation positioned in the palatal wall opposite the aperture are common in shell bead assemblages (d'Errico *et al*., 2009: pp.16053–4; but see Stiner *et al*., 2013: p.384, Table 2). Second, the morphology of the perforation is inconsistent with those made by many molluscan predators, which are generally neater, but is reasonably consistent with some humanly perforated archaeological examples (d'Errico *et al*., 2009; Stiner *et al*., 2013; Barton and Roberts, 2015; Campmas *et al*., 2016). It is noteworthy that perforated shell beads are known from Nanna's Cave (Caldey Island, Pembrokeshire, Wales), including a specimen of *Tritia reticulata* shell, which are all of early Holocene age (David and Walker, 2004: p.328). However, although it is possible that our shell (Fig.5) is a bead, we remain cautious about this interpretation because natural agents can produce similar holes in similar positions (d'Errico *et al*., 2009; Stiner *et al*., 2013; Campmas *et al*., 2016), and because this is only a single specimen from a poor archaeological context.

Based on their position beneath Campbell's spoil, loose matrix and the similarity of the sedimentary makeup to small patches of intact deposits adhering to the cave wall, as well as the presence of a clay pipe stem alongside prehistoric material, we interpret Context 1007 and part of 1006 as spoil from Wood's work. This interpretation is consistent with the different condition of bones, including some that are mineralized and surely of Pleistocene age. However, it is impossible to conclude that any archaeological material in this unit derives from the same Palaeolithic occupation(s) that are evidenced by Wood and Campbell's excavations. The lithic artefacts are all undiagnostic and could belong to many periods of prehistory, and other material in this unit is late prehistoric rather than Palaeolithic. Furthermore, judging by the raw material makeup of the lithic assemblage, it might be different from that recovered by Wood and Campbell. Their collections contain artefacts made from both flint and black chert (Table 1). Although we were specifically looking for black chert, the 2012 excavations recovered only worked flint (Table 1).

	Terrestrial														Marine											
	Cornu aspersum		*Pomatias elegans*		*Cepaea* sp.		*Cepaea nemoralis*		*Discus rotundatus*		*Oxychilus cellarius*		*Candidula intersecta*		*Steromphala cineraria*		*Phorcus lineatus*		*Patella vulgata*		*Littorina littorea*		*Nucella lapillus*		*Ostrea edulis*	
Context	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)	n=	Frag(s)
1005	8		2																							
1006	5		7	x	1		1		1										1	x	41	x	3	x		x
1007	3		23				2		4		3		3		1		1		32	x	84	x	8	x		
1008		x																		x	1	x				

Table 3 (above)*: Details of molluscan species from contexts underlying Campbell's spoil in Trench 1 (i.e. Contexts 1005–1008). Note the large number of marine species, and particularly periwinkles* (Littorina littorea) *in Contexts 1006 and 1007. "x" indicates fragment(s) present. Note: these counts do not include the* Tritia reticulata *shell in Figure 5.*

Lab Reference	Sample Code	Material	$\delta^{13}C$	Date BP
OxA–27398	LH1	Shell (*Littorina littorea*)	1.92	2899 ± 27

Table 4 (above)*: Radiocarbon date for one of the* Littorina littorea *shells from Trench 1 (Context 1007).*

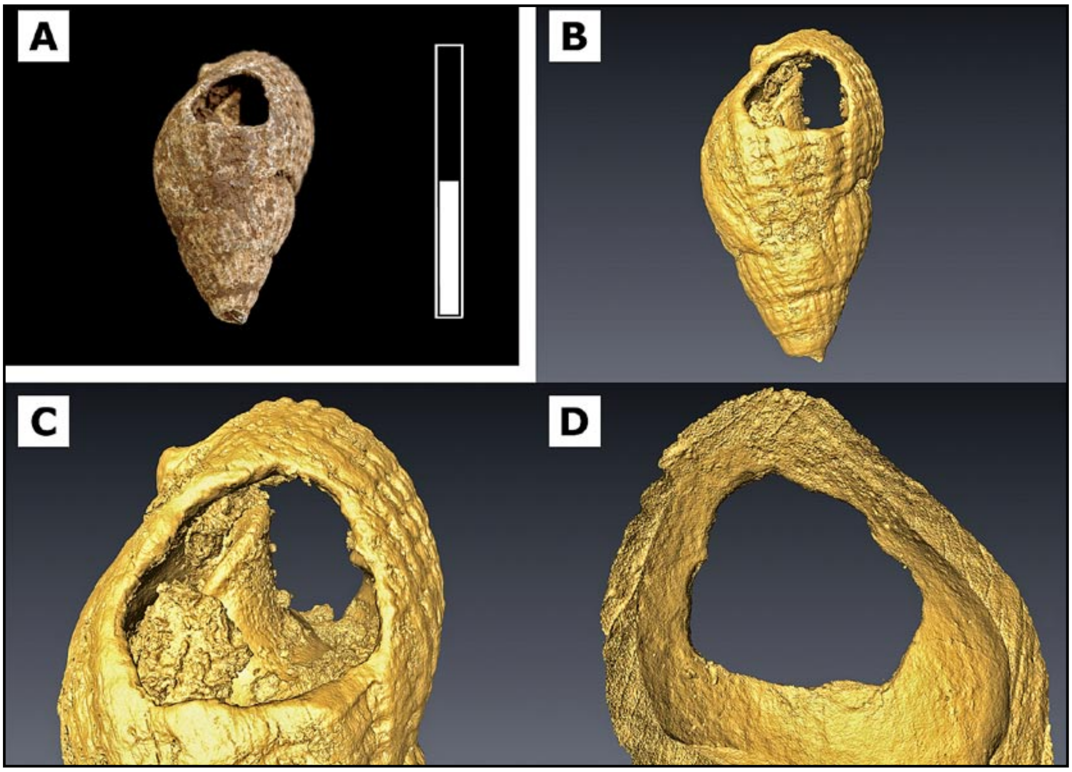

***Figure 5**:*
Perforated Tritia reticulata *shell from Trench 1 (Context 1007). The shell was scanned at the Natural History Museum, London, on a Nikon Metrology HMX ST 225 microCT scanner.*
Voxel size is 0.012 mm^3 (isometric). The isosurface was rendered in AVIZO software (FEI Software, Burlington, Mass.).

The figure includes:

(A) a photograph of the shell's dorsal surface;

(B) an isosurface rendering of the microCT data showing the dorsal surface of the shell;

(C) an isosurface rendering showing in detail the dorsal surface of the perforation in the shell;

(D) an isosurface rendering showing in detail the ventral surface of the perforation revealed by a clipping slice through the shell's main axis.

Two further stratigraphically lower contexts (1008 and 1009), of which only a small amount was excavated, may also derive from Wood's clearance of the cave.

Trenches 2 and 3 were positioned to test spoil material within the cave (Fig.3). In Trench 2 spoil left from Campbell's work was excavated to a maximum depth of 75cm, and was found to contain modern animal bone, two small flint chips (Table 1), some mid-20th century plastic and a hand-trowel. Shallow (c.25cm) disturbed deposits in Trench 3, at the rear of the cave, contained only modern animal bone.

Long Hole's place in the British Palaeolithic

Long Hole's most important collections are those from Wood's work over 150 years ago, which means that interpreting the cave's archaeological evidence encounters two familiar problems.

First, the museum collections from Wood's work are only a small proportion of what actually lay in the sediments he dug out. A good comparison for Long Hole would be the cave site of Trou du Renard in Belgium, where an Aurignacian lithic assemblage is thought to have been left behind over a short period by hunters around 36,000 cal BP (Dinnis and Flas, 2016). Excavated in 1900, the Trou du Renard assemblage is probably not totally complete – (no flint in the collection measures less than 5mm in its largest dimension) – but for its time the collection of material was undoubtedly meticulous. In Wood's existing collections from Long Hole, the smallest artefact measures 28.5mm in its largest dimension (Table 1). At Trou du Renard, only 31% of lithic artefacts are ≥28.5mm (n=156 of 501). Presuming that the Long Hole lithic assemblage had not already undergone size sorting before its deposition in the cave, we can therefore surmise that at least two thirds of worked lithics dug out by Wood are not represented in museum collections. In reality, however, this percentage is bound to be a great deal higher, as such a calculation makes the unrealistic assumption that all artefacts ≥28.5mm were recognized by Wood's excavators, collected and accessioned in museums.

The second issue is the lack of stratigraphical information regarding Wood's archaeological finds. Unlike other Gower sites that Wood excavated, Long Hole yielded fossils of extinct species and seemingly-associated man-made artefacts in intact rather than disturbed deposits. Publications in the years following the excavation show how even then the precise detail of these apparent associations was understood to be critical. Falconer (1864: pp.248–49) felt the need to correct an assertion of Sir Charles Lyell (1864, cited in Falconer, 1864), which was subsequently repeated by Lartet and Christy (1864, cited in Falconer, 1864), that worked flints were found beneath a rhino skull. Falconer (1864) clarified that there was no such specific association between artefacts and a rhino skull, but that both came from the same intact deposits. Such insights into Wood's discoveries are, however, few and far between. Without a proper record of his work it is simply impossible to reconstruct the cave's stratigraphy in any meaningful way.

Despite these sizeable caveats, however, several lines of evidence do allow Long Hole's Palaeolithic occupation to be reconstructed. Falconer (1868) confirms that one of Wood's worked flints was found next to (but not beneath) rhino remains. The last rhinoceros to inhabit Britain was the woolly rhino (*Coelodonta antiquitatis*), which became locally extinct towards the end of the Middle Devensian, around 35,000 cal BP (Dinnis *et al*., 2016) (Fig.1). Although Wood's faunal collection suggests a mixing of different faunal assemblages (Falconer, 1868; Garrod, 1926; Allen and Rutter, 1948; Campbell, 1977), much of it is consistent with a typical Middle Devensian cave accumulation (Currant and Jacobi, 2011; Dinnis *et al*., 2016). Most notably this includes hyaena, which probably introduced many of the animal bones into the cave, and for which there is no good evidence in Britain after c.36,000 cal BP (Dinnis *et al*., 2016). Based on faunal evidence a Middle Devensian age for at least some of Wood's lithic assemblage therefore seems probable.

Furthermore, the presence of both black chert and flint in Campbell's and Wood's lithic collections provides an important link between the two. As Campbell's excavated sequence was well stratified, it therefore offers contextual information that can reasonably be applied to both collections. Only a few bones identifiable to species were found in the layers from which Campbell's lithic assemblage came, but the species represented (fox, horse and reindeer: Campbell, 1977, Vol.2, p.78; Lister, 1984: p.2) are consistent with a Middle Devensian attribution. The underlying layer (Layer A2c) contained a larger and more characteristically Middle Devensian fauna, which crucially includes both hyaena and woolly rhino (Campbell, 1977, Vol.2, p.78). Campbell's conclusion that these layers are Middle Devensian, and that the overlying cold event in his sequence is the Last Glacial Maximum, therefore seems reasonable. Like previous researchers, we therefore see the archaeological evidence as documenting occupation during the Middle Devensian.

In terms of the nature of the occupation(s) at Long Hole, Campbell (1977; see above) suggested the occurrence of both Late Middle Palaeolithic and LRJ archaeological material at the site, which would mean at least two different phases of late Neanderthal presence (Fig.1). Campbell (1977: p.60) saw only tentative evidence for the earlier, Late Middle Palaeolithic occupation, and only in his own collections. His Layer A2b yielded what were, in his opinion, a humanly struck piece of limestone and a bone tool. The limestone fragment can be rejected as natural, an opinion shared by Green (1984: p.16). Furthermore, our search of Campbell's collection revealed no obviously humanly modified bone. A specimen matching Campbell's (1977: p.60) description of his putative bone tool comes from the same layer and square he reports; however, rather than being humanly modified, the shaping and polish on the bone are consistent with carnivore action. We therefore see no evidence for an archaeological component to Campbell's Layer A2b, and thus no evidence for a Late Middle Palaeolithic at the cave[2].

Campbell (1977) argued for a later LRJ occupation at Long Hole based on a fragment of a characteristic blade-point in Wood's collection, but unfortunately did not specify which of Wood's artefacts he was referring to. None of the pieces studied by us is a blade-point fragment. The most likely candidate is a blade fragment figured by Campbell[3] (1977: fig.97, artefact 6), which displays ventral modification vaguely reminiscent of the flat, invasive retouch seen on LRJ blade-points. However, based on Campbell's illustration the ventral modification is likely to be damage rather than shaping. We therefore agree with Jacobi (cited in Barton and Collcutt, 1986: p.89) that there is no blade-point fragment in Wood's collection. Furthermore, contrary to Campbell's (1977) suggestion, none of the lithics from his own excavations can be related to blade-point manufacture. We can also note that the bladelet core and carinated burin in Wood's collection (Table 1) are unlike artefacts found in any LRJ assemblage (Jacobi, 2007; Flas, 2008). Therefore, unlike at nearby Paviland Cave (Swainston, 2000; Jacobi, 2007; Flas, 2008), there is no evidence at Long Hole for late Neanderthals with LRJ technology.

Although there is no convincing evidence for late Neanderthals at Long Hole, it is possible to draw conclusions from the cave's Palaeolithic collections. First, we can note that lithic artefacts are Upper (rather than Middle) Palaeolithic in nature. Wood's collection contains blades, burins, endscrapers and a bladelet core (Table 1), all attributable to this period. Furthermore, one of Wood's artefacts is a carinated burin (Dinnis, 2012c), an artefact now usually considered a core used to produce extremely small bladelet tools. This piece shares technological similarities with those in the large Aurignacian assemblage from Paviland Cave (Dinnis, 2012c). More evidence for a link between Long Hole and the Paviland Aurignacian comes from the lithic sources used. At both sites black Carboniferous chert was clearly an important material, alongside flint (Table 1 [Wood/Campbell collections]: Swainston, 1999; 2000). Additionally, at both sites some good-quality flint has been imported to the site, possibly from a source in Southwest England or a now submerged source in the Bristol Channel (Swainston, 2000). At both sites this was used alongside poorer and presumably locally collected drift flint.Given their proximity and the similarities in stone tool form and raw materials, it is very likely that the Long Hole collection evidences the same Aurignacian occupation seen at Paviland. Given the exclusive association between the European Aurignacian and early modern humans, we can therefore conclude that the Long Hole material was left behind by some of Britain's earliest modern human occupants.

Precisely when Britain's first modern human occupation took place is still unclear. The claim for an age of 43,000 cal BP for a modern human fossil from Kents Cavern (Higham *et al*., 2011) does not withstand scrutiny. Stratigraphical anomalies in the area of Kents Cavern where the fossil was found mean that any age calculated for the fossil based on radiocarbon dates from nearby material will always be an approximation (White and Pettitt, 2012; Proctor *et al*., 2017). Furthermore, such an age runs counter to the archaeological record of northwest Europe, which based on current understanding shows modern human presence no earlier than 41,000 cal BP (Banks *et al*., 2013; Flas *et al*., 2012; Dinnis, 2015). Features of some of the stone tools from British Aurignacian sites indicate that they belong to the period 37–35,000 cal BP (Dinnis, 2012a,b), a period when evidence from numerous Belgian sites shows substantial activity nearby (Miller *et al*., 2004; Flas, 2008; Flas *et al*., 2012; Dinnis, 2015; Dinnis and Flas, 2016). This age is currently the best guess for the Aurignacian at Paviland Cave and therefore also for occupation at Long Hole. Notably, such an age would be marginally older than the most recent radiocarbon age of 34–33,000 cal BP for the Red Lady of Paviland burial (Jacobi and Higham, 2008). Given the long and chequered history of radiocarbon dating the Paviland collections, however, the Red Lady's age is far from settled (see Jacobi and Higham, 2008; also see Bourrillon *et al*., 2018; Dinnis *et al*., 2019), and it is perfectly possible that he was in fact interred during the site's Aurignacian occupation. Unfortunately, with no archaeological sediments remaining at Paviland Cave (Aldhouse Green, 2000b), this is a question that can only be answered through more work on the 19th and early 20th century collections.

It is difficult to know what else may be learned from Long Hole's archaeological collections but, given its good stratigraphical context, Campbell's collection clearly has the most potential. The record of pollen and fauna from his intact sequence is already understood as nationally important (Campbell and Bowen, 1989: pp.46–47), but recently developed techniques offer the possibility for further work. Campbell (1977: p.60) attempted radiocarbon dating of bone from his sequence but this failed due to insufficient preservation of collagen. However, new research at the Oxford Radiocarbon Accelerator Unit is aimed at dealing with low-collagen bones and ensuring that the dates they yield are accurate (Jacob *et al*., 2018; T. Devièse pers. comm., 2018). In the near future it might therefore be possible to produce dates for Campbell's faunal sequence, thereby confirming its Middle/Late Devensian age. In addition, the fragmentary nature of most bone recovered meant that it could not be identified to species (Campbell, 1977). The development of the ZooMS (Zooarchaeology by Mass Spectrometry) method (Buckley *et al*., 2009) now allows even small fragmentary bones to be identified, often to species level. Together, ZooMS and new dating of Campbell's Long Hole sequence could provide a high-resolution Devensian faunal record that is rare for Britain, and could also offer new data for understanding the timing and environmental backdrop of the Palaeolithic occupations both at Long Hole and at Paviland Cave.

---

[2] *One worked bone point from Long Hole is housed at the National Museum of Wales (Cardiff). The artefact (accession number 92.232H/1) was donated to the museum in 1992 and was reported to have been found loose on the surface inside the cave 'around 40 years' prior to that date. We can therefore be confident it is not Campbell's suggested bone tool. The form of the bone point does not allow confident assessment of its age, beyond it probably belonging to a period prior to the early Bronze Age.*

[3] *We assume this is the artefact in the Pitt Rivers Museum unstudied by us (see Table 1).*

Conclusions

Excavation of Long Hole in 1861 by Colonel Wood was extensive, emptying most or all of the cave's bone-bearing sediments. Wood recovered a faunal assemblage, which, at least in part, belongs to the Middle Devensian, as well as a collection of worked lithic artefacts. At the time Wood's work was important for helping to prove a deep antiquity of human occupation. Later work by John Campbell on the platform outside the cave helped to contextualise Wood's collections. Campbell's excavations revealed an intact sequence of deposits apparently spanning most or all of the last glacial cycle, including lithic material in a layer of probable Middle Devensian age. The most recent excavation at the site – undertaken in 2012 and described here – was designed to test spoil deposits from previous work. This excavation recovered further archaeological material, including evidence for later prehistoric activity.

Our re-analysis of archaeological collections from the cave has allowed several conclusions concerning its Palaeolithic occupation. Although heavily selected and with little ancillary contextual information, Wood's lithic assemblage is clearly the most important archaeological material from the site. Campbell's smaller collection of lithic artefacts is consistent with Wood's collection both technologically and in relation to the raw materials used for stone tool manufacture. Although small and undiagnostic, Campbell's well-stratified collection therefore supports a Middle Devensian age for the material found by Wood, as does the fact that at least one of Wood's flint artefacts was found in proximity to rhinoceros remains. Wood's lithic assemblage bears similarity to Aurignacian material from nearby Paviland Cave, left by some of Britain's very earliest modern human occupants. The material at Long Hole probably represents the same occupation, which is currently understood as taking place 37–35,000 cal BP. Following a reassessment of the evidence, earlier Neanderthal occupations, proposed by Campbell, cannot be supported.

Acknowledgements

We acknowledge the help of the late Richard Turner, Jonathan Berry, Heather Bassett-Jones, Stewart Rowden and Emma Brown in organizing the 2012 fieldwork, and a particularly warm thanks to Nigel Ajax-Lewis for his help with organization and for being an enthusiastic visitor in sometimes inclement weather during the dig. Rob Colley very kindly carried out the bat inspection. Thanks are due to Charley Coleman and Craig Williams for their help with figures and photos. We are grateful to Katerina Douka for organizing the radiocarbon date, and to her and Nick Barton for discussions about the shell in Figure 5.Thanks also to Emma Williams at Swansea Museum for help with study of Wood's collections. Finally, thanks to the two anonymous BCRA reviewers for their useful comments. This work was funded jointly by the Leverhulme Trust-supported Ancient Human Occupation of Britain project and the BCRA's CSTRI scheme.

References

Aldhouse-Green, S H (Ed.), 2000a. *Paviland Cave and the "Red Lady": a definitive report*. [Bristol: Western Academic and Specialist Press.]

Aldhouse-Green, S H, 2000b. The Paviland Caves. Excavation, survey and assessment in 1997. 1–18 in Aldhouse-Green, S H (Ed.), *Paviland Cave and the "Red Lady": a definitive report*. [Bristol: Western Academic and Specialist Press.]

Aldhouse-Green, S, Scott, K, Schwarcz, H, Grün, R, Housley, R, Rae, A, Bevins, R and Redknap, M, 1995. Coygan Cave, Laugharne, South Wales, a Mousterian site and Hyaena Den: a report on the University of Cambridge excavations. *Proceedings of the Prehistoric Society*, Vol.61, 37–79.

Aldhouse-Green, S, Peterson, R and Walker, E (eds), 2012. *Neanderthals in Wales: Pontnewydd and the Elwy Valley Caves*. [Oxford: Oxbow.]

Allen, E E and Rutter, J G, 1948. *A survey of the Gower caves with an account of recent excavations, Part II*. [Swansea: Welsh Guides.]

Banks, W E, d'Errico, F and Zilhão, J, 2013. Human–climate interaction during the Early Upper Paleolithic: testing the hypothesis of an adaptive shift between the Proto-Aurignacian and the Early Aurignacian. *Journal of Human Evolution*, Vol.64, 39–55.

Barton, N and Collcutt, S, 1986. *A Survey of English and Welsh Palaeolithic Cave Sites*. Unpublished report for English Heritage and CADW.

Barton, N and Roberts, A, 2015. Shell beads in the Mesolithic of Britain. 191–207 in Ashton, N and Harris, C (eds), *No Stone Unturned*: *Papers in Honour of Roger Jacobi*. Lithics Studies Society Occasional Paper 9.

Bourrillon, R, White, R, Tartar, E, Chiotti, L, Mensan, R, Clark, A, Castel, J.-C, Cretin, C, Higham, T, Morala, A, Ranlett, S, Sisk, M, Devièse, T and Comeskey, D J, 2018. A new Aurignacian engraving from Abri Blanchard, France: Implications for understanding Aurignacian graphic expression in Western and Central Europe. *Quaternary International*, Vol.491, 46–64.

Buckley, M, Collins, M, Thomas-Oates, J and Wilson. J C, 2009. Species identification by analysis of bone collagen using matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry. *Rapid Communications in Mass Spectrometry*, Vol.23, 3843–3854.

Campbell, S and Bowen, D Q, 1989. *Geological Conservation Review: Quaternary of Wales*. [Peterborough: Nature Conservancy Council.]

Campbell, J B, 1977. *The Upper Palaeolithic of Britain: A Study of Man and Nature in the Late Ice Age*. (2 volumes). [Oxford: Clarendon Press.]

Campmas, E, Chakroun, A and Merzoug, S, 2016. Données préliminaires sur l'exploitation de la malacofaune marine par les groupes ibéromaurusiens de l'abri Alain (Oran, Algérie). *Paléo*, Vol.27, 83–104.

Cooper, L P, Thomas, J S, Beamish, M G, Gouldwell, A, Collcutt, S N, Williams, J, Jacobi, R M, Currant, A and Higham, T F G, 2012. An Early Upper Palaeolithic open-air station and mid-Devensian hyaena den at Grange Farm, Glaston, Rutland, UK. *Proceedings of the Prehistoric Society*, Vol.78, 73–93.

Currant, A P and Jacobi, R, 2011. The Mammal Faunas of the British Late Pleistocene. 165–180 in Ashton, N M, Lewis S G and Stringer, C B (eds), *The Ancient Human Occupation of Britain*. [Amsterdam: Elsevier.]

d'Errico, F, Vanhaeran, M, Barton, N, Bouzouggar, A, Mienus, H, Richter, D, Hublin, J-J, McPherron, S P and Lozouet, P, 2009. Additional evidence on the use of personal ornaments in the Middle Paleolithic of North Africa. *PNAS*, Vol.106(38), 16051–16056.

David, A and Walker, E A, 2004. Wales during the Mesolithic period. 299–337 in Saville, A (Ed.), *Mesolithic Scotland and its Neighbours*. [Edinburgh: Society of Antiquaries of Scotland.]

Davies, W, 2001. A very model of a modern human industry: new perspectives on the origins and spread of the Aurignacian in Europe. *Proceedings of the Prehistoric Society*, Vol.67, 195–217.

Dawkins, W B, 1874. *Cave Hunting: Researches on the evidence respecting the early inhabitants of Europe*. [London: Macmillan and Co.]

Dinnis, R and Flas, D, 2016. Trou du Renard and the Belgian Aurignacian. *Proceedings of the Prehistoric Society*, Vol.82, 1–25.

Dinnis, R and Proctor, C, 2015. (Re)discovery of a major cave entrance at Kents Cavern, Devon, UK. *Cave and Karst Science*, Vol.42, 59.

Dinnis, R and Stringer, C, 2014. *Britain: One Million Years of the Human Story*. [London: Natural History Museum Press.] 152 pp.

Dinnis, R, 2012a. The archaeology of Britain's first modern humans. *Antiquity*, Vol.86, 627–641.

Dinnis, R, 2012b. The timing of Aurignacian occupation of the British Peninsula. *Quartär*, Vol.59, 67–83.

Dinnis, R, 2012c. Identification of Long Hole (Gower) as an Aurignacian site. *Lithics: The Journal of the Lithic Studies Society*, Vol.33, 17–29.

Dinnis, R, 2015. A survey of northwestern European Aurignacian sites and some comments regarding their potential chrono-cultural significance. 59–76 in Ashton, N and Harris, C (eds.), *No Stone Unturned: Papers in Honour of Roger Jacobi*. Lithics Studies Society Occasional Paper 9.

Dinnis, R, Pate, A and Reynolds, N, 2016. Mid-to-Late Marine Isotope Stage 3 mammal faunas of Britain: a new look. *Proceedings of the Geologists' Association*, Vol.127, 435–444.

Dinnis, R, Bessudnov, A, Reynolds, N, Devièse, T, Pate, A, Sablin, M, Sinitsyn, A and Higham, T, 2019. New data for the Early Upper Paleolithic of Kostenki (Russia). *Journal of Human Evolution*, Vol.127, 21–40.

Falconer, H, 1864. On the asserted occurrence of flint knives under a skull of the extinct *Rhinoceros hemitoechus*, in an ossiferous cave in the peninsula of Gower. *The Annals and Magazine of Natural History, including Zoology, Botany, and Geology*, Vol.14, 248–249.

Falconer, H, 1868. Note on the occurrence of wrought flints, in association with two extinct species of rhinoceros, &c., in 'Long Hole' Cave, Gower. 538–540 in Murchison, C (Ed.), *Palaeontological Memoirs and Notes of the Late Hugh Falconer, Volume II: Mastadon, Elephant, Rhinoceros, Ossiferous Caves, Primeval Man and his Contemporaries*, 538–540. [London: R Hardwicke.]

Flas, D, 2008. La transition du Paléolithique moyen au supérieur dans la Plaine Septentrionale de l'Europe. *Bulletin de la Société Royale Belge d'Anthropologie et de Préhistoire*, Vol.119, 5–254.

Flas, D, Tartar, E, Bordes, J-G, Le Brun-Ricalens, F and Zwyns, N, 2012. New perspectives on the Aurignacian from Spy: lithic assemblage, osseous artifacts and chrono-cultural sequence. 231–255 in Rougier H and Semal, P (eds), *Spy Cave: 125 Years of Multidisciplinary Research at the Betche Aux Rotches (Jemeppe-Sur-Sambre, Province of Namur, Belgium)*, Volume 1. *Anthropologica et Praehistorica*, Vol.123.

Garrod, D A E, 1926. *The Upper Palaeolithic age in Britain*. [Oxford: Clarendon Press.]

Green, H S, 1984. The Palaeolithic period. 11–33 in Savory, H N (Ed.), *Glamorgan County History Volume II Early Glamorgan: Pre-History and Early History*. [Cardiff: Glamorgan County History Trust Ltd.]

Green, S and Walker, E, 1991. *Ice Age Hunters: Neanderthals and Early Modern Hunters in Wales*. [Cardiff: National Museum of Wales.]

Haesaerts, P, Borziac, I, Chekha, V P, Chirica, V, Damblon, F, Drozdov, N I, Orlova, L A, Pirson, S and van der Plicht, J, 2009. Climatic signature and radiocarbon chronology of Middle and Late Pleniglacial loess from Eurasia: comparison with the marine and Greenland records. *Radiocarbon*, Vol.51, 301–318.

Higham, T, Compton, T, Stringer, C, Jacobi, R, Shapiro, B, Trinkaus, E, Chandler, B, Gröning, F, Collins, C, Hillson, S, O'Higgins, P, FitzGerald, C and Fagan, M. 2011. The earliest evidence for anatomically modern humans in northwestern Europe. *Nature*, Vol.479, 521–524.

Jacob, E, Querci, D, Caparros, M, Barroso Ruiz, C, Higham, T and Devièse, T, 2018. Nitrogen content variation in archaeological bone and its implications for stable isotope analysis and radiocarbon dating. *Journal of Archaeological Science*, Vol.93, 68–73.

Jacobi, R M, 1999. Some observations on the British Early Upper Palaeolithic. 35–40 in Davies, W and Charles, R (eds), *Dorothy Garrod and the Progress of the Palaeolithic: Studies in the Prehistoric Archaeology of the Near East and Europe*. [Oxford: Oxbow.]

Jacobi, R, 2007. A collection of Early Upper Palaeolithic artefacts from Beedings, near Pulborough, West Sussex, and the context of similar finds from the British Isles. *Proceedings of the Prehistoric Society*, Vol.73, 229–325.

Jacobi, R M and Higham, T F, 2008. The 'Red Lady' ages gracefully: new ultrafiltration AMS determinations from Paviland. *Journal of Human Evolution*, Vol.55, 898–907.

Jacobi, R and Higham, T, 2011. The British Earlier Upper Palaeolithic: settlement and chronology. 191–222 in Ashton, N M, Lewis, S G and Stringer, C B (eds), *The Ancient Human Occupation of Britain*. [Amsterdam: Elsevier.]

Jacobi, R M, Higham, T, Haesaerts, P, Jadin, I and Basell, L S, 2010. Radiocarbon chronology for the Early Gravettian of northern Europe: new AMS determinations for Maisieres-Canal, Belgium. *Antiquity*. Vol.84, 26–40.

Lartet, E and Christy, H, 1864. Sur des figures d'animaux gravées ou sculptées et autres produits d'art et d'industrie rapportables aux temps primordiaux de la période humaine. *Revue archéologique*, Vol.9, 233–267.

Lister, A M. 1984. The fossil record of elk (*Alces alces* (L.)) in Britain. *Quaternary Newsletter*, 44, 1–7.

Lyell, C, 1863. *Antiquity of Man*. [London: John Murray.]

Lyell, C, 1864. *Antiquity of Man* (3rd Edition). [London: John Murray.]

McBurney, C B M, 1959. Report on the first season's fieldwork on British Upper Palaeolithic cave deposits. *Proceedings of the Prehistoric Society*, Vol.25, 260–268.

Miller, R, Haesaerts, P and Otte, M (eds). 2004. *L'atelier de taille aurignacien de Maisières-Canal (Belgique)*. [Liège: ERAUL 110.]

Pesesse, D and Flas, D, 2012. The Maisierian, at the edge of the Gravettian. *Proceedings of the Prehistoric Society*, Vol.78, 95–109.

Pettitt, P B and White, M, 2012. *The British Palaeolithic: Human Societies at the Edge of the Pleistocene World*. [Abingdon: Routledge.]

Pettitt, P B, Jacobi, R M, Chamberlain, A T, Pike, A W G, Schreve, D, Wall, I, Dinnis, R and Wragg Sykes, R, 2009. Excavations outside Church Hole, Creswell Crags: the first three seasons (2006–8). *Transactions of the Thoroton Society of Nottinghamshire*, Vol.113, 35–53.

Proctor, C, Douka, K, Proctor, J W and Higham, T, 2017. The age and context of the KC4 Maxilla, Kent's Cavern, UK. *European Journal of Archaeology*, Vol.20, 74–97.

Rasmussen, S O, Bigler, M, Blockley, S P, Blunier, T, Buchardt, S L, Clausen, H B, Cvijanovic, I, Dahl-Jensen, D, Johnsen, S J, Fischer, H, Gkinis, V, Guillevic, M, Hoek, W Z, Lowe, J J, Pedro, J B, Popp, T, Seierstad, I K, Steffensen, J P, Svensson, A M, Vallelonga, P, Vinther, B M, Walker, M J C, Wheatley, J J and Winstrup, M, 2014. A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three synchronized Greenland ice-core records: refining and extending the INTIMATE event stratigraphy. *Quaternary Science Reviews*, Vol.106, 14–28.

Roberts, J, 1888. Cat's Hole Cave and Park Cwm Tumulus, Gower. *Annual Report and Transactions of the Swansea Scientific Society*, 1887–8, 15–23.

Sánchez-Goñi, M F, Landais, A, Fletcher, W J, Naughton, F, Desprat, S and Duprat, J, 2008. Contrasting impacts of Dansgaard–Oeschger events over a western European latitudinal transect modulated by orbital parameters. *Quaternary Science Reviews*, Vol.27, 1136–1151.

Schreve, D, Howard, A, Currant, A, Brooks, S, Buteux, S, Coope, R and Toms, P, 2013. A Middle Devensian woolly rhinoceros (*Coelodonta antiquitatis*) from Whitemoor Haye Quarry, Staffordshire (UK): palaeoenvironmental context and significance. *Journal of Quaternary Science*, Vol.28, 118–130.

Stiner, M C, Kuhn, S L and Güleç, E, 2013. Early Upper Paleolithic shell beads at Üçağızlı Cave I (Turkey): Technology and the socioeconomic context of ornament life-histories. *Journal of Human Evolution*, Vol.64, 380–398.

Swainston, S, 1999. *A study of the lithic collections from Paviland Cave, and the site in its wider context*. Unpublished M.Phil. dissertation, University of Wales College, Newport.

Swainston, S, 2000. The lithic artefacts from Paviland. 95–113 in Aldhouse-Green, S H (Ed.), *Paviland Cave and the "Red Lady": a definitive report*. [Bristol: Western Academic and Specialist Press.]

Touzé, O, 2018. Aux prémices du Gravettien dans le Nord-Ouest européen. Étude de la production des pointes lithiques à Maisières Canal (province de Hainaut, Belgique). *Bulletin de la Société préhistorique française*, Vol.115, 455–495.

Turner, A, 2000. The Paviland mammalian fauna. 133–140 in Aldhouse-Green, S H (Ed.), *Paviland Cave and the "Red Lady": a definitive report*. [Bristol: Western Academic and Specialist Press.]

Voelker, A H L (and workshop participants), 2002. Global distribution of centennial-scale records for Marine Isotope Stage (MIS) 3: a database. *Quaternary Science Reviews*, Vol.21, 1185–1212.

Walker, E A, Case, D, Ingrem, C, Jones, J R, Mourne, R, 2014. Excavations at Cathole Cave, Gower, Swansea. *Proceedings of the University of Bristol Spelaeological Society*, Vol.26, 131–169.

White, M and Pettitt, P, 2012. Ancient digs and modern myths: the age and context of the Kent's Cavern 4 maxilla and the earliest *Homo sapiens* specimens in Europe. *European Journal of Archaeology*, Vol.15, 1–30.