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125 years of exploration and research at Gough's Cave (Somerset, UK)

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Our understanding of the recolonization of northwest Europe in the period leading up to the Lateglacial Interstadial relies heavily on discoveries from Gough's Cave (Somerset, UK). Gough's Cave is the richest Late Upper Palaeolithic site in the British Isles, yielding an exceptional array of human remains, stone and organic artefacts, and butchered faunal remains. A particularly intriguing aspect of the human remains is the evidence of butchery, including intensive removal of soft tissue, fracturing of long bones to extract marrow, and chewing and consumption of spongy bone. Additionally, human skulls were modified into skull cups, and a radius shaft was engraved, suggesting cannibalism was ritualistic in nature. Following this brief but intense Late Upper Palaeolithic activity, the site appears to have been largely abandoned by later prehistoric peoples, making the discovery of an almost complete skeleton of a Mesolithic man puzzling. Although it remains unclear whether he was intentionally buried or if he died there, ancient DNA (aDNA) shows that he had a Western European hunter-gatherer origin, distinct from both earlier Magdalenian individuals found at the site and later Neolithic colonists. This article presents a review of the history of exploration and research conducted at Gough's Cave over the past 125 years.

Introduction

Within the entrance to Gough's Cave, early in 1983, pieces of bone were observed by Elizabeth and Roger Jacobi protruding from a small standing section in the northwest corner of the feature known as 'Cheddar Man Fissure', which produced the Mesolithic skeleton of 'Cheddar Man' in 1903. Small bone fragments were recovered in 1984 and 1985 by the then head guide, Mr Barrett, and were presumed to have fallen from this small standing section. Examination of these fragments by Chris Stringer and his colleague Andrew Currant suggested that several pieces might be of human origin.

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The vulnerability of this section to damage from erosion and recurrent episodic flood waters emanating from the subterranean stream below Cheddar Man Fissure prompted three phases of rescue excavations between 1986 and 1992. The investigations were conducted as part of a joint effort led by the late Roger Jacobi (at the time at the University of Lancaster) alongside Andrew Currant and Chris Stringer (British Museum (Natural History)). Although the quantity of sediment excavated was relatively small, it yielded a noteworthy assemblage of Late Upper Palaeolithic artefacts. These included flint tools such as the characteristic 'Cheddar Points', engraved bone and ivory fragments – some bearing deliberately scored 'notations' – an amber pebble, and an enigmatic '*batôn de commandement*' made from reindeer antler, all intermingled with human and other large mammal remains, many of which had been butchered. The unprecedented results from the excavation of this unexpected pocket of artefact- and bone-rich sediment opened a new chapter in the long history of scientific – and earlier, less rigorous – investigations of Gough's Cave, which is celebrated for its rich assemblage of Late Upper Palaeolithic human and archaeological remains.

Gough's Cave (51°16′53″N, 2°45′51″W, approximately 30 metres above sea level) is one of many caves in Cheddar Gorge, south-west England, located at the base of the west-facing cliff near the entrance to the gorge (Fig. 1a, c-f). Exploration of the cave dates back to its discovery and opening as a tourist attraction by Richard Cox Gough between 1892 and 1898. Since then, the cave entrance and facilities have been developed to accommodate visitors, making Gough's Cave one of the UK's main subterranean tourist attractions. From a scientific perspective, the finds uncovered in the cave have been pivotal in reshaping our understanding of the Upper Palaeolithic and Mesolithic periods in Europe. In particular, Gough's Cave plays a crucial role in advancing our understanding of the recolonization of north-west Europe shortly before the Lateglacial Interstadial, as well as the genetic relationships, behaviours, and cultural practices of the populations involved in this colonization event.

In this paper, we present a review of the history of exploration and research conducted at Gough's Cave over the past 125 years.

Excavations

The first description and one of the earliest illustrations of the cave entrance were provided by the Reverend John Skinner (Rector of Camerton, near Bath; reproduced in Irwin 1985: 97, pl. I), who visited Gough's Cave in 1816 (Fig. 2c). For most of the nineteenth century, the cave entrance was gated and used as a cart shed. Richard Cox Gough moved to Cheddar in 1868 and obtained the lease for the cave in 1877, when it became known as Gough's Old Cave. At the time, the cave was almost completely filled, but Gough's ambition was to open up the entrance and reveal a cave that could rival the dimensions and beauty of Cox's Cave, located only a few hundred metres further down the gorge. This ambition sparked a rivalry with his uncle, George Cox, who had discovered Cox's Cave in 1837 (Johnson 1967) (Fig. 2b).

Members of the Geologists' Association visited the cave in August 1880, and after 'a short search [they] brought to light numerous imbedded bones' (Sollas 1881). Gough began excavation and blasting of the cave in 1890, digging trenches through the mound of rock and debris blocking the entrance to improve public access (Irwin 1985). In 1892, he eventually broke into the main part of the cave, revealing large fonts of stalagmite (the Fonts). This new section was subsequently named 'Gough's New Cave' (Jacobi 1985). By then, Richard Gough and his two sons had removed around 500

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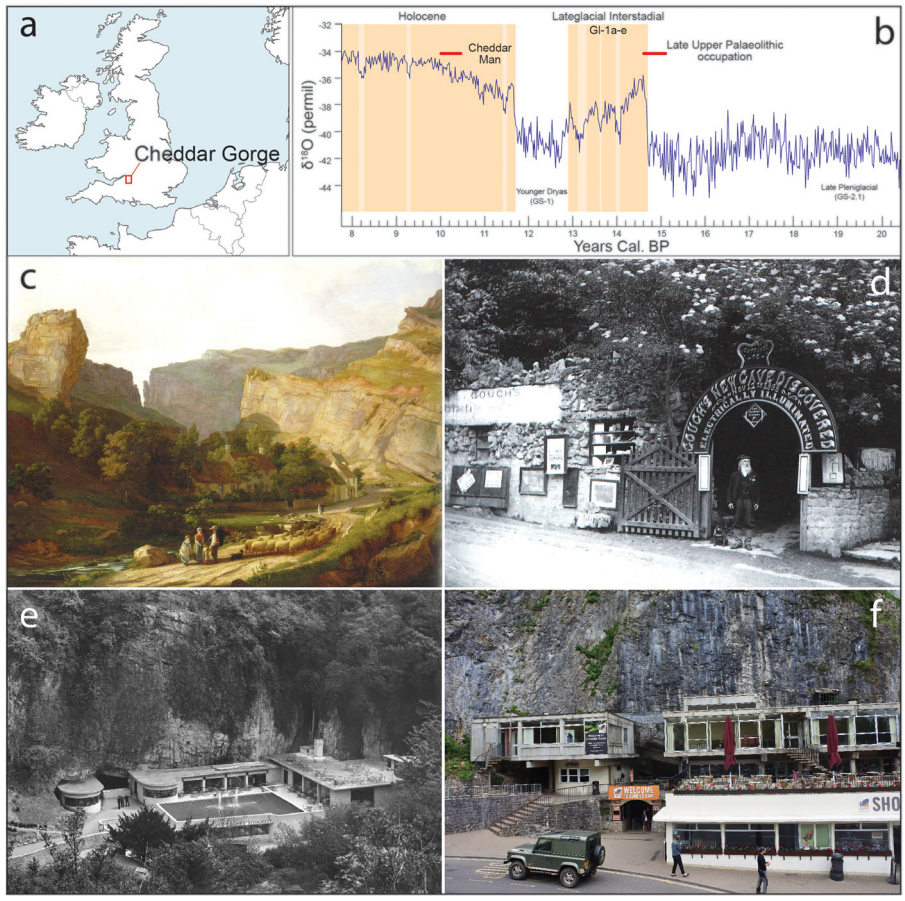

Figure 1. a. Location of Cheddar Gorge (UK) (Drawing credit S.M. Bello). b. Climate change during the Late Glacial and early Holocene derived from North Greenland Ice core $\delta^{18}O$ values, INTIMATE event stratigraphy and radiocarbon dates for the Upper Palaeolithic occupation and Cheddar Man (modified from Charlton *et al.* 2022). c. Painting of Cheddar Gorge by George Vincent, *c.*1820 (credit Gallerix). d. Richard Cox Gough at the entrance to the cave compound shortly after the site was opened to visitors (Postcard). e. The Caveman Restaurant and entrance to Gough's Cave, designed by Sir Geoffrey Jellicoe and built in 1934 (Photo credit RIBA, RIBA8048). f. Visitor Centre and entrance to Gough's Cave in 2000s (Photo S.M. Bello).

tons of sediment to reach the chambers with the stalagmite formations and enhance access to the cave's interior for tourists (as reported by the *Wells Journal*; Irwin 1985). Contemporary reports suggest that much of the clearance work was carried out at night under candlelight, with the spoil loaded into panniers and transported to dumps outside the cave by donkeys. It is certain that some of the archaeologically richest cave deposits were removed from the cave at this time, though their whereabouts remain unknown.

The excavation of the downward-sloping entranceway also led to regular flooding in this area after periods of heavy rain. Water would first rise in the area of the Fonts, forming a pool that expanded towards both the front and back of the cave. To address this issue, Gough dug a drainage trench from the Fonts towards a recess to the left of the cave entrance (the Vestibule Fissure, now known as Cheddar Man Fissure; Fig. 2a).

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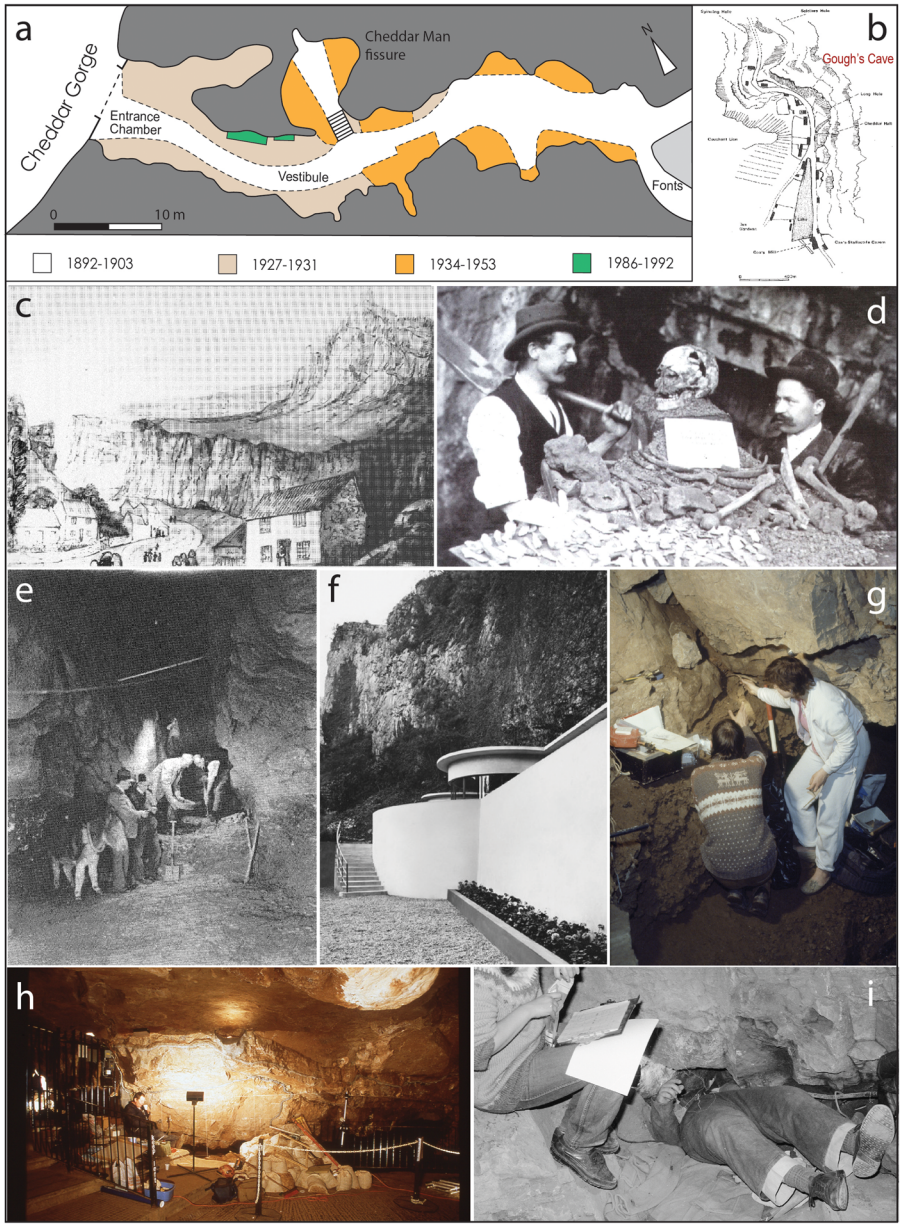

Figure 2. a. Plan of Gough's Cave showing outlines of the different phases of excavation 1892-1990 (modified from Jacobi 1985). b. Tithe map of Cheddar Gorge, 1872. c. Illustration of the cave entrance by the Reverend John Skinner (Rector of Camerton near Bath; reproduced in Irwin 1985: 97, pl. I). d. Photo on a 1904 postcard illustrating the discovery of Cheddar Man at Gough's Cave by Arthur Gough (left) and William Gough (right) (Postcard). e. Digging in Gough's Cave in early 1935 (reproduced from Jacobi 1985: 108, pl. 2). f. New restaurant building at the entrance of the cave in 1934 (Photo credit RIBA, RIBA24728). g. Small bone fragments recovered by Mr Barrett, and analysed by Elizabeth (right) and Roger Jacobi (left) in 1983. h-i. 1986-7 and 1989-90 excavations conducted by Roger Jacobi, Chris Stringer, and Andy Currant (Currant having a tea break in h, and laying under the cliff rock in i) (g-i: Photos © The Trustees of the Natural History Museum, London).

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Gough was unable to oversee these crucial phases of the excavation, as he died on 25 February 1902. The lease of the cave then passed to his widow, Frances, and his elder son, Arthur, who managed it until 1933, when he was succeeded by Captain Brend. The original lease, established with Richard Gough, expired in 1927, at which point control of the cave reverted to the Longleat Estates and ultimately to the present Marquess of Bath.

In December 1903, during the building of the drainage trench inside the Vestibule Fissure, workmen uncovered an almost complete human skeleton (Fig. 2d). The skeleton, which was sealed under the same stalagmite layer which also covered the Late Pleistocene/Late Upper Palaeolithic deposits at the cave entrance, was subsequently named Cheddar Man (Tratman 1975). Although the record of its discovery is sketchy, and the skull was inadvertently removed by workmen in the cave, Henry Nathaniel Davies in April 1904 described with some precision the context and position of the skeleton: 'The skull was lying in a slightly-lower position than the pelvis and lower extremities … The legs were drawn up, one of the arms bent so as to bring the hand to the back of the head, and the whole position of the skeleton such as would have been assumed by the body of a drowned man swirled into its last resting-place by a rushing torrent' (Davies 1904: 342, 340, fig. 4). This interpretation of a 'washed body' is contradicted by Tratman (1975), who argues that the height of the rock lip at the cave mouth, combined with the existing talus, would have effectively prevented a body from being washed into the cave. A photo reproduced by Seligman and Parson (1914: fig. 1, pl. XXIII), with the caption 'Gough's Cave, Fissure showing articular facet of tibia and other bones in situ' is also indicative that the body was found in a (semi-)articulated flexed position, potentially suggesting the deliberate placement of the body.

The discovery of Cheddar Man significantly boosted the popularity of Gough's Cave compared to Cox's Cavern. In the following years, excavations extended towards the back and sides of the cave, accompanied by the installation of new wall-mounted lighting. By the 1930s, advertising for Gough's Cave was widespread, and by 1934, annual visitor numbers had reached 200,000 (Irwin 1985).

Further excavation near the Cheddar Man remains and beneath the stalagmite layer uncovered a significant number of long, narrow flakes, numerous worked flints, and a splint bone of *Equus*. Excavations outside the fissure also yielded bone and antler implements, notably a modified fragment of reindeer antler (Seligman & Parsons, 1914: 243, fig. 2). Even at the time, these implements were presumed to predate Cheddar Man.

The first systematic excavations of Gough's Cave were conducted by R.F. Parry, who excavated the remaining deposits at the cave's entrance over several winter seasons between 1927 and 1932 (Parry 1928; 1929*a*; 1929*b*; 1931) (Fig. 2e). These efforts uncovered Romano-British and Early Iron Age finds from the upper layers, as well as over 7,000 Upper Palaeolithic lithic artefacts, engraved bone artefacts, and fragments of human and other mammalian remains from the deeper deposits (Parry 1931). Parry recorded all finds daily, assigning them individual spit numbers and noting their original horizontal and vertical positions relative to a datum line at the cave's entrance. Unfortunately, no records of these measurements have survived.

During the 1930s, significant changes were made to the entrance of Gough's Cave, including the construction of a new office and restaurant (Fig. 2f). In 1934, sediments south of the cave entrance were removed to accommodate the restaurant's foundation, yielding Roman and Bronze Age artefacts (Weymouth 1934). Excavations of the Cheddar Man Fissure were also completed, removing the remaining fragments

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associated with Cheddar Man (Jacobi 1985). Between 1934 and 1953, A.V. Painter continued work in the cave, excavating the distal sections of Late Glacial sediments in the deeper and less accessible recesses of the cave (Donovan 1955) (Fig. 2a).

In the 1950s and 1960s, rescue excavations conducted around the cave entrance during the construction of new buildings recovered prehistoric artefacts and faunal remains, including an unshaped amber fragment and a fragment of an adult human right parietal bone (Jacobi 1985; Tratman 1952; 1953). During the winter of 1957-8, the remaining ridge at the cave entrance was removed, and the current level walkway was created at the location of the new 'Iron Gate' (Jacobi 1985), though only a small number of finds were recovered during this work. Additional excavation occurred in 1968 during maintenance of the entrance buildings. While the precise context of these discoveries is unclear, human bones, potentially of prehistoric origin, were uncovered at the base of the cliff south of the cave entrance (Tratman, Donovan & Musgrave 1972).

The most recent phase of excavations was conducted in 1986-7 and 1989-90 under the direction of the late Roger Jacobi (then at the University of Lancaster, University of Nottingham), Andy Currant, and Chris Stringer of the Natural History Museum, London (Currant, Jacobi & Stringer 1989). These excavations focused on three small sections along the north wall of the cave (Fig. 2g-i) and may represent some of the last remnants of Late Glacial sediments surviving within Gough's Cave. This work also initiated a new phase of scientific analysis of the lithic, faunal, and human collections uncovered at the site since 1903.

The Mesolithic finds

Cheddar Man is the almost complete skeleton excavated in 1903 from Cheddar Man Fissure by Arthur and William Gough (Figs 2d and 3a). Only one other fossil is certainly associated with the skeleton, a lower canine of a wildcat (Jacobi 1985). Regarding lithic artefacts, no Mesolithic material was initially identified during the various stages of excavation. However, a re-examination of Parry's published material by Newell, Constandse-Westermann and Meiklejohn (1979) suggested the possible presence of at least four Mesolithic microliths, although these could not be directly associated with the skeleton (Fig. 4d).

The first report of the human skeleton was delivered by Henry Nathaniel Davies, just four months after its discovery. He recognized the modernity of the skull compared to Neanderthal specimens and described it as a 'man about 5 feet 5 inches in height, with an exceptionally thick dolichocephalic skull, slightly prognathous jaws, and rather prominent superciliary ridges' (Davies 1904: 346). The concurrent discovery of lithic and organic artefacts in the same archaeological areas as Cheddar Man (though the exact stratigraphy and distribution of these finds remain unclear) initially led to confusion regarding the age of the remains. Davies assumed that some of the lithic artefacts – such as flint knives, scrapers, and borers – were associated with the skeleton. Based on this, he concluded that 'the human remains were probably of late Palaeolithic age (Magdalénien of Mortillet)' (Davies 1904: 347). This hypothesis was supported by Seligman and Parsons (1914), who analysed the 'artefacts of stone and reindeer antler found with the skeleton' and concluded that 'There is thus strong reason to believe that Mr. Davies is correct in assigning the remains to the late Palaeolithic or, as he definitely states, to Mortillet's 'Magdalenian' Age of Culture at the close of the Palaeolithic Period' (Seligman & Parsons 1914: 245). In addition, Seligman and Parsons (1914) provided a detailed description of Cheddar Man's skull, teeth, and limb morphology, concluding

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Figure 3. a. Plan of Gough's Cave, red square indicates the approximate position where the skeleton was supposedly found (modified from Jacobi 1985). b. Cast of Cheddar Man in Cheddar Fissure, with reconstruction of how it was supposedly deposited in the fissure. The location and position of the body are only indicative, as they do not match the first descriptions and limited excavation information, and are mainly for touristic purpose (Photo credit S.M. Bello). c. Analysis and conservation of Cheddar Man at the Natural History Museum, London (left, Efstratia Ververiotou, Senior Conservator at the NHM; right, Louise Humphrey, Merit Researcher at the NHM). d. Chris Stringer (Research Leader at the NHM) holding the Kennis brothers' reconstruction of Cheddar man, compared to e. an earlier reconstruction by the University of Manchester. (c-e: Photos © The Trustees of the Natural History Museum, London).

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that he was a young male individual, approximately 164 centimetres tall, whose cranial morphology bore some resemblance to that of medieval Englishmen.

In the Catalogue of Fossil Hominids (Part II: Europe) by Oakley, Campbell and Molleson (1971), the full list of remains for Cheddar Man (designated as Gough's Cave 1) is provided, with its stratigraphic age attributed to the Early Flandrian. The Flandrian interglacial, or Flandrian stage, is a regional term used by geo-archaeologists of the British Isles to refer to the Holocene. The Early Flandrian period is understood to span from approximately 12,000 to 9,000 years ago. Radiocarbon dating (uncalibrated) of Gough's Cave 1's tibia (9,080 ± 150 BP; BM-525; Barker, Burleigh & Meeks 1971) and talus (9,100 ± 100 BP; OxA-814; Gowlett, Hall, Hedges & Perry 1986) supports this chronological framework (Fig. 1b).

Tratman (1975) focused on the deposition of Cheddar Man trying to determine whether it was the product of accidental death by drowning (as suggested by Davies 1904), or it was a deliberate burial as suggested by Donovan (1955: 91). He concluded (1975: 21) that Cheddar Man

> was deliberately and carefully buried as a complete or nearly complete collection of bones held together with sinews and ligaments. Most of the flesh had been removed or allowed to decay by previous exposure of the body. Even loose phalanges seem to have been gathered up and placed inside the skull. The burial was made in a crouched position with the limb bones certainly generally in normal articulation.

This description would suggest a secondary burial of the body, a hypothesis that could be supported by Newell *et al.* (1979), who described the presence of cut marks on the calotte and face as well as breakage on fresh bone in the right clavicle, right humerus, and left femur. In contrast, we have not observed any cut marks or signs of post-mortem human-induced manipulation on Cheddar Man. We believe the more parsimonious conclusion is that the body was deliberately deposited complete in a flexed position as part of a primary burial, without any manipulation of the body, body parts, or bones (Fig. 3b). The presence of a single burial is unusual for the Mesolithic period, during which communal burials of multiple individuals were more common. For example, Aveline's Hole, located just about a mile from where Cheddar Man was found, has yielded one of the largest Mesolithic cemeteries in Britain (Mullan 2019).

Dental and skeletal analyses of Cheddar Man, along with comparisons to other Mesolithic individuals, were conducted by Frayer (1978) and Newell *et al.* (1979) and later summarized by Stringer (1985). The dental analyses concluded that Cheddar Man was gracile compared to the average Upper Palaeolithic and Mesolithic male. However, skeletal characteristics suggested closer affinities with Mesolithic groups.

Pathological traumas were first noted by Donovan (1955) and Tratman (1975) on the left parieto-temporal region and left maxilla, initially interpreted as potential causes of death. It is more likely, however, that these injuries occurred post-mortem as suggested by Humphrey and Stringer (2002), who identified a lesion on the supraorbital margin of the right orbit resulting from an infection possibly caused by osteomyelitis. The infection could have originated from an infected sinus or have been a consequence of an injury. This infection was also highlighted in the first reconstruction of Cheddar Man, produced by the University of Manchester (Fig. 3e).

Subsequent anatomical studies of Gough's Cave 1 (Cheddar Man) were published in the *Bulletin of the Natural History Museum, Geology series* between 2001 and 2003, covering various aspects of the skeleton: the cranial remains (Humphrey &

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Stringer 2002); the dental remains (Hawkey 2003); the pectoral girdle and upper limbs (Churchill 2001*b*); the hand bones (Trinkaus 2001); the axial skeleton (Churchill & Holliday 2002); the pelvis and lower limbs (Trinkaus 2003); as well as assessments of body size and shape (Holliday & Churchill 2003) and sex and age at death (Trinkaus, Humphrey, Stringer, Churchill & Tague 2003). These studies concluded that the Cheddar Man skeleton belonged to a male individual, though certain anatomical features, such as aspects of the facial skeleton and coxal bone, along with the relatively small overall size, are features more commonly associated with females. The age indicators were more consistent, pointing to a young adult age, estimated to be between eighteen and twenty-three years old. Cheddar Man's height, similar to that of other Mesolithic individuals, was estimated to be about 1.66 metres, with a relatively low body mass of about 66 kilogrammes. Interestingly, while Cheddar Man's overall morphological pattern reflects typical European body proportions, some characteristics (e.g., relatively longer distal limb segments) have been attributed to traits inherited from an earlier, predominantly African gene pool, no longer observed in Europe today (Holliday & Churchill 2003: 43).

The genetic ancestry of Cheddar Man was more recently investigated at the Natural History Museum (NHM), London, by Brace and colleagues (2019). This study, which analysed whole-genome data from six Mesolithic British individuals including Cheddar Man, revealed persistent genetic affinities between Mesolithic Britons and Western European hunter-gatherers. The analysis showed that Cheddar Man was not closely related to the earlier Magdalenian individuals found in the same cave, whose ancestry is entirely derived from the Goyet cluster (details below). Furthermore, analysis of Cheddar Man's nuclear DNA indicated that he was a typical member of the Western European hunter-gatherer population of his time. His most likely phenotype included blue-green eyes, dark brown or black hair, and dark or dark-to-black skin. Additionally, there was no genetic adaptation for lactase persistence into adulthood (Brace *et al.* 2019).

The work of Brace and colleagues (2019) has resulted in a TV documentary for which Cheddar Man's cranium was CT-scanned and a 3D model reproduced by paleo-artists Alfons and Adrie Kennis, based on the 3D morphology model and Brace and colleagues' (2019) genetic analysis. The reconstruction can be seen at the NHM, next to the original skeleton of Cheddar Man (Fig. 3c-d).

The Upper Palaeolithic finds

During the Late Upper Palaeolithic, Gough's Cave was ideally situated with access to a diversity of habitats between lowland marshes, lakes, floodplains of the Somerset Levels and the Bristol Channel, and the high plateau of the Mendips. The vegetation in the vicinity of the cave probably consisted of alder, willow, and hazel woodland, with a steppe-type vegetation growing on the Mendip uplands and a patchy growth of birch, hazel, and alder in sheltered areas of the gorge (Currant 1986; Harrison 1986; Leroi-Gourhan 1985; Price 2003). Environmental studies also suggest that summer temperatures during the Magdalenian occupation phase may have been close to those of today, although winters were substantially colder.

Around 14,800 years ago, a resilient group of hunter-gatherers established camp in Cheddar Gorge, occupying the numerous cave sites within the gorge, including Gough's Cave. They left behind one of the richest assemblages in north-western Europe of Magdalenian butchered human and faunal remains, along with lithic and organic

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artefacts, providing exceptional insights into their behaviours and how they adapted to the harsh cold of the Late Glacial Maximum. Genetically, this group can be traced back to origins in southern Europe, and their vibrant cultural practices included funerary rites that entailed ritual cannibalism.

Radiocarbon dating

The antiquity of the finds at Gough's Cave was suspected since the discovery of Cheddar Man in 1903. The first attempt to obtain absolute dates for the faunal remains from the site was made in the 1980s through radiocarbon dating of amino acids from bone collagen. Four dates obtained were closely grouped, ranging from 12,360 to 12,800 ± 170 BP (uncalibrated; Gillespie, Gowlett, Hall, Hedges & Perry 1985). These dates appeared to be slightly older than a series of radiocarbon dates run concurrently by the British Museum (Burleigh, Jacobi & Jacobi 1985). Subsequent radiocarbon analyses seemed to confirm these initial results (Gowlett *et al.* 1986; Hedges, Housley, Law & Perry 1988; Hedges, Housley, Law, Perry & Gowlett 1987).

A programme of AMS radiocarbon dating was conducted by Roger Jacobi and Tom Higham in the mid to late 2000s (Fig. 4a-b). They specifically selected human remains and faunal remains that had been anthropically modified to directly link the dates to human presence. By applying Bayesian modelling to the latest ultrafiltered AMS radiocarbon determinations on the human remains, butchered animal bones, and artefacts, they were able to push the date back. This suggested that the Magdalenian occupation of Gough's Cave began during the rapid climatic amelioration marking the transition from Greenland Stadial 2 (GS-2) to Greenland Interstadial 1 (GI-1e), occurring after 14,700 cal BP (Jacobi & Higham 2009; 2011).

More recently, a new Bayesian modelling approach using OxCal (v.4.4) and the IntCal20 calibration curve, applied to the published radiocarbon dates from Gough's Cave, provided a boundary start date for the site of 15,070–14,850 cal BP and a boundary end date of 14,960–14,610 cal BP, with a 95% confidence interval (Charlton *et al.* 2022). This new radiocarbon calibration places the site's Late Upper Palaeolithic occupation before the rapid climate warming at the beginning of the Late Glacial Interstadial (∼14,700 BP) (Fig. 1b). Nevertheless, all these recent dates are remarkably tightly clustered, indicating that the Magdalenian occupation was likely very brief, potentially lasting only two or three human generations (Jacobi & Higham 2009) (Fig. 4a). This makes Gough's Cave a valuable snapshot of the environment and the human groups living in north-west Europe around 14,700 years BP.

Lithic and organic industry

The discovery of Cheddar Man prompted more rigorous excavations within the 'cave-earth' resulting in the discovery in 1904 of 'beautifully patinated' flint flakes. Henry Davies compared them 'with those figured by G. and A de Mortillet in their "Musée Préhistorique" (1881, pl xix, figs. 120, 122, & pl. xxi, figs. 135-37, 39), with some blades from Kent's Cavern shown in the British Museum Collection, and with a set obtained from Bryan Cave, Torquay, shown in the British Museum (Natural History) Collections', and recognized their striking resemblance with all these Palaeolithic examples (Davies 1904: 345). Further discoveries and analyses were conducted by Seligman and Parsons (1914), who described scrapers, end-scrapers (the most abundant type), burins, and flakes, and attributed these finds to the Later Upper Palaeolithic culture. In particular, the association of these lithic artefacts with one of the '*batôn-de-commandements*' uncovered at the cave, which was thought to be an implement that only appears in the

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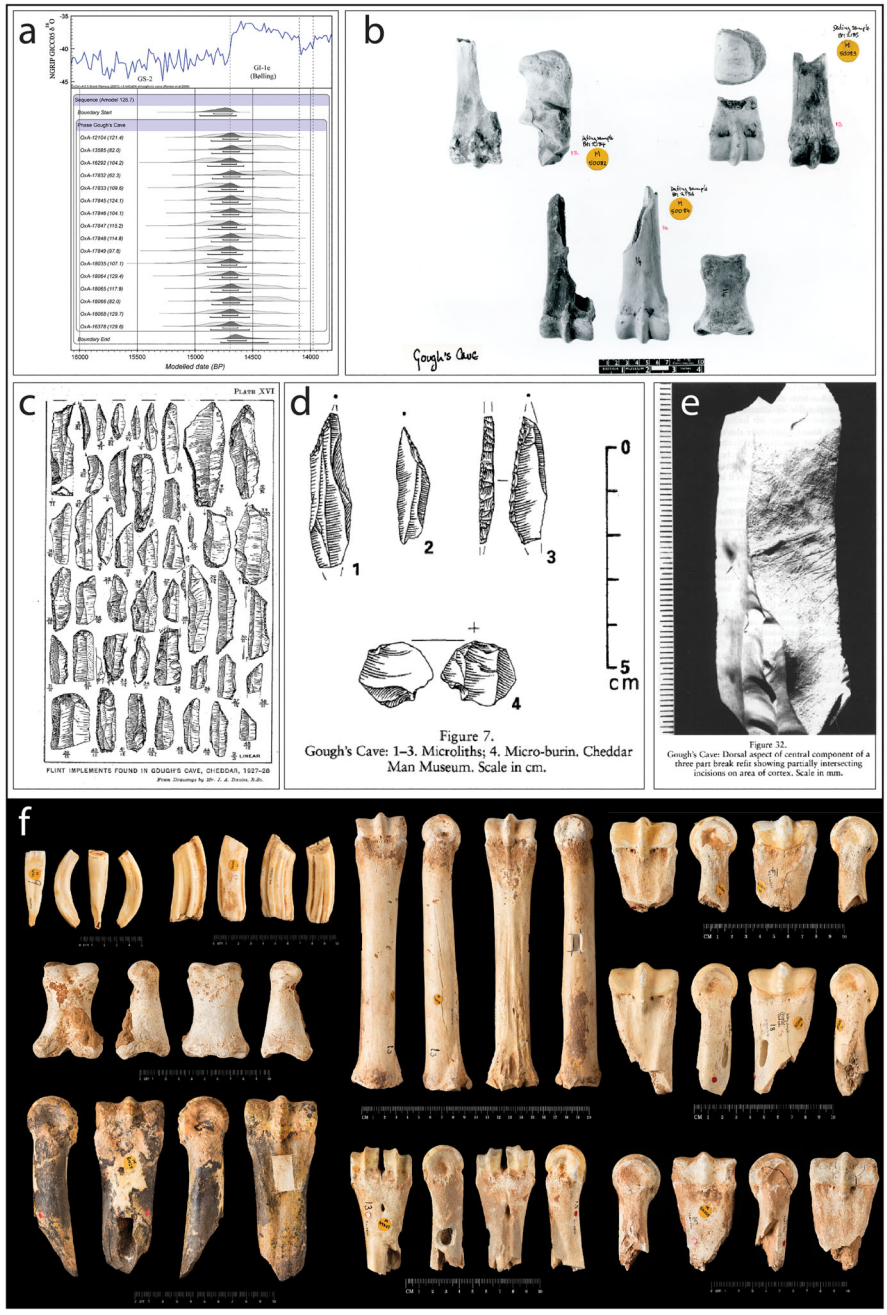

Figure 4. a. Radiocarbon dating results from Jacobi and Higham (2009). b. Example of faunal fragments selected for radiocarbon dating at the NHM. c. Drawings of lithic artefacts from Gough's Cave by Parry (1929*a*: 106, pl. XVI). d. Drawings of four microliths likely to be Mesolithic, reproduced from Jacobi (2004: 13, fig. 7). e. '*Dorsal aspect of central component of a three part break refit showing partially intersecting incisions on area of cortex*' in Jacobi (2004: 49, fig. 32). f. Photos of the nine knapping tools uncovered at Gough's Cave. (b and f: Photos © The Trustees of the Natural History Museum, London).

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Magdalenian culture, 'seemed to indicate beyond cavil that part at least of the contents of the cave were of Magdalenian age' (Seligman & Parsons 1914: fig. 3, 245, 248).

Davies accompanied the report of Parry's 1927-8 excavations at Gough's Cave with detailed descriptions of several hundred worked flints and flint fragments, and beautiful drawings of over 100 specimens (in Parry 1929*a*: 106-11) (Fig. 4c). His conclusion mirrors Seligman and Parsons' interpretation (1914) of a mainly Magdalenian industry. Parry (1931) reported a total of 7,000 flints uncovered at Gough's Cave, of which 947 were assumed to be implements. However, Tratman (1975), after revision of the entire lithic collection (catalogued and uncatalogued fragments), was only able to locate a total of 3,071 flints, commenting that the 'discrepancies between the total in the table and those given by Parry remain unexplained' (Tratman 1975: 19). Parry (1931: 48, fig. 2) also illustrated a stone slate with several sub-parallel lines engraved across it, and one line running perpendicularly to them. We are unaware of the current whereabouts of this specimen; however, it could provide new insights into the Magdalenian tradition of engraving stone plaquettes, a practice so far limited in the British Isles to the island of Jersey (Bello *et al.* 2020).

The most comprehensive analysis of the lithic industry at Gough's Cave was conducted by Roger Jacobi in his extensive ninety-page paper (Jacobi 2004). Jacobi examined over 2,200 pieces of humanly modified flint and chert, of which 550 were retouched tools. He classified these tools into several categories: end-scrapers (8.5% of retouched tools), composite tools (1.6%), piercers/becs (4%), burins (11.1%), knives (0.4%), retouched truncations (6.3%), pieces with continuous lateral retouch (8.7%), notches/denticulated pieces (1.8%), abruptly modified pieces (44.6%), fragments of pointed 'Magdalenian' blades (5.3%), pieces with discontinuous lateral retouch (5.3%), and miscellaneous tool fragments (Jacobi 2004: 23). His study also identified a unique specimen for the British Isles' Magdalenian period, engraved on its cortex (Jacobi 2004: 49, fig. 32) (Fig. 4e). Jacobi concluded that these artefacts were likely left in the cave after the hunting of wild horses and red deer during the summer and winter. He also suggested that the cave may have functioned as a funerary site.

Intriguingly, among the retouched tools, Jacobi (2004) identified several pieces for which the retouch was made using soft or organic knapping tools. However, no such organic knapping tools had been recognized at the cave until recently. A complete re-assessment of the faunal collection in 2020, aimed at identifying these elusive tools, led to the discovery of nine organic knapping implements (Bello, Créte, Galway-Witham & Parfitt 2021) (Fig. 4f). Despite their rarity, the retouchers from Gough's Cave are remarkable, showing a degree of variability that suggests the use of a composite knapping kit. Seven bones were used as hammers, with a strong action that caused the breakage of the metapodial. Two teeth were manipulated as pressure-flakers. While most of the pieces appear to be expedient tools, the horse molar was almost certainly a curated object, reused multiple times over an extended period. These knapping tools seem to be concentrated in a small area within the rear part of the entrance chamber, located between ten and twenty metres from the mouth of the cave. This suggests the area was a specialized zone within the daylight section of the cave where flint knapping took place. Lithic analyses and descriptions from early excavations at the site align with this conclusion (for a detailed discussion, see Bello *et al.* 2021: 20-1).

Only teeth and metapodials were used as retouchers at Gough's Cave. This anatomical bias can be linked to the general bias in early excavation practices, where workers retained the more recognizable elements – such as teeth, metapodials, and

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complete bones – while discarding unidentified and smaller bone fragments (Currant 1986; Parfitt & Bello 2024). It is noteworthy that the rarity of organic stone-working tools appears to be a recurrent feature of Magdalenian culture across Europe. Bello and colleagues (2021) identified only sixteen Magdalenian sites, including Gough's Cave, with published evidence of organic knapping tools. This scarcity has been linked to an increased use of hard hammers and 'stone retouchers' (Riek 1973; Taute 1965), but it may also be partially attributed to a lack of interest in 'unspecialized' tools. The Magdalenian culture is known for its wide range of specialized organic tools, such as lissoirs, perforated batons, barbed points, harpoons, and needles, as well as exceptional mobiliary art, which may have attracted more archaeological attention. Gough's Cave is a typical example of this skewed focus; indeed, while knapping tools were only rediscovered in 2020, the specialized bone tool technology at the site immediately captured scholarly interest.

The importance of the '*batôn-de-commandement*' found at Gough's Cave was recognized as early as 1914, with their presence being used to attribute the assemblage to the Magdalenian culture (Seligman & Parsons 1914). Three perforated batons were uncovered at the site during different excavation campaigns: the main portion of baton NHMUK PA E 7783 was discovered in 1903 during excavations in the 'Cheddar Man Fissure' (Seligman & Parsons 1914), and a second small fragment that refitted the main specimen was found during Parry's excavation on the north side of the cave entrance in 1929–30, at least 2.4 metres from the main fragment (Parry 1931). A second perforated baton (NHMUK PA E 7782) was discovered during Parry's excavation in 1927 on the north side of the cave entrance (Parry 1929*a*). The third and final baton (NHMUK PV UNREG 4196) was found in 1989 during excavations led by Jacobi, Currant and Stringer (Jacobi 2004; Jacobi & Higham 2009; Macphail & Goldberg 2003) (Fig. 5a).

The earliest descriptions and illustrations of these important finds were made by Seligman and Parsons (1914), St. George Gray (in Parry 1929*a*), and R.C.C. Clay (1929). Patricia McComb (1989) conducted a technological analysis of the first baton (NHMUK PA E 7783) and commented on the second (NHMUK PA E 7782) based on photographs. All of these studies highlighted the symbolic significance of the batons. The third baton (NHMUK PV UNREG 4196), which had never been previously studied, received a complete macro- and microscopic analysis in 2019, alongside the two other specimens. Technological analysis by Lucas, Galway-Whitham, Stringer and Bello (2019) concluded that the Gough's Cave perforated batons were not purely symbolic, as the term '*bâton de commandement*' might suggest, but were functional tools. Their reconstruction of the *chaîne opératoire* indicates that the batons were repetitively used, resulting in extensive use-wear on the edges of the perforations, which was re-adjusted by the production of deep engraved curved lines within the perforation of each baton. Additionally, the oblique bands of incisions on the shafts of two of the batons were engraved, possibly to improve grip on the smooth antler surface. Lucas *et al.* (2019) concluded that the modifications to the perforations and shafts of the three batons support the hypothesis that they were used for tasks involving ropes. Specifically, they may have functioned as cable blockers for habitat structures, parts of animal harnesses, or guides for sledges.

Several other specialized organic artefacts were uncovered at Gough's Cave. One of the earliest illustrations of a bone instrument was provided by Seligman and Parsons (1914: fig. 2), who described a splint bone of *Equus*, which appeared pointed and worn. Little is currently known about this bone implement, and it is also possible that

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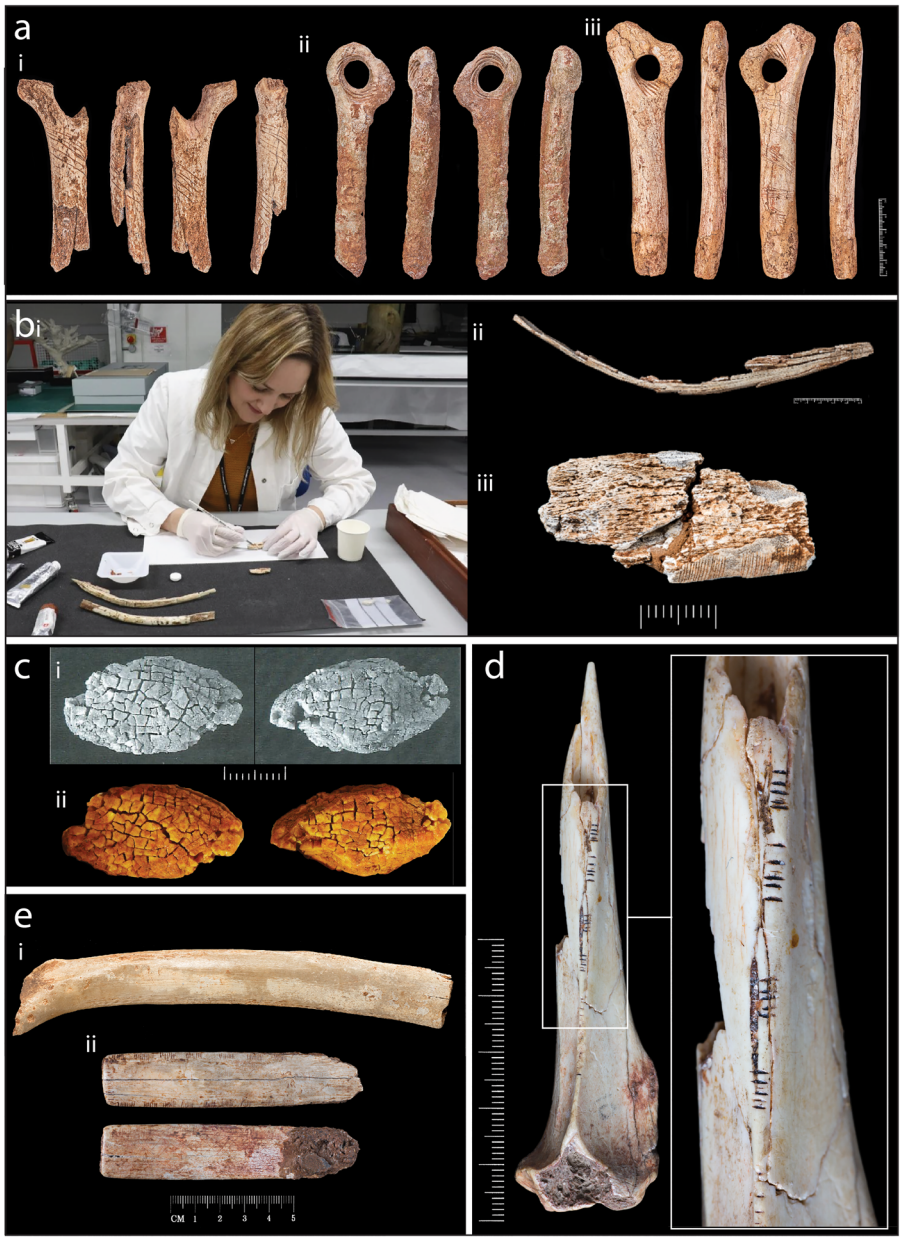

Figure 5. a. The three perforated batons from Gough's Cave: (i) NHMUK PA E 7783, (ii) NHMUK PA E 7782, (iii) NHMUK PV UNREG 4196. b. Lydia Amies (i) consolidating the ivory rods (ii) and (iii) detail of the incisions on one of the fragments. c. Reproduction of the photo of the amber fragment (NHMUK PV Unreg 3829) published by Charles (1989: 401, figs 2 and 3) and macro-photos of the two sides of the amber using digital microscope MLOV DM602 Pro 10.1 (credit S.M. Bello). d. Bone awl (NHMUK PV UNREG 4189) made from the proximal portion of a tibia of hare (*Lepus timidus*) and detail of the incisions. e. (i) Proximal portion of a cut-off rib (NHMUK PV Unreg 3846) and (ii) distal portion (NHMUK PV UNREG 4190) of a rib shaft which is engraved on both sides, possibly used as a smoother (lissoir). The two fragments may belong to the same large mammal (probably a horse). (a-b, d-e: Photos © The Trustees of the Natural History Museum, London).

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the observed modifications were entirely natural. More evident organic artefacts were described by St. George Gray (in Parry 1929*a*). He detailed two of the perforated batons (as mentioned above), as well as parts of a cylindrical rod of ivory (likely mammoth), split along its natural grain. Gray recognized similarities with ivory rods found in Kent's Cavern (Garrod 1926) and Paviland Cave (Sollas 1913). A second specimen was later described as a mammoth ivory weapon head (sagaie) by Currant, Jacobi and Stringer (1989). Smaller ivory fragments (seven in total) were further analysed by Charles (1989; 1991), who interpreted the sub-parallel incisions on the preserved bone surface as 'notations', although he also noted that 'any attempt at interpreting the function of these notations would seem unwise at present' (Charles 1989: 407). The ivory rod fragments have recently been conserved at the NHM, London, with further analyses ongoing (Fig. 5b).

Charles (1989: 401) also described a small unshaped amber pebble found in 1985, which may have been part of a larger amber block originally discovered in 1950 (Tratman 1952; 1953). The pebble, which split during excavation, revealed a blood-red interior, confirming its identification as an amber fragment (Fig. 5c). Although the specimen has not been extensively described, its exotic origin remains intriguing. The closest known source of amber during the Lateglacial period was likely located at the western edge of the North Sea Basin. The long-distance transportation of this amber may exemplify the high mobility of Magdalenian groups, suggesting seasonal journeys that could have spanned over 300 kilometres in one direction (Parfitt, Crété, Dinnis, Lucas & Bello, forthcoming).

Gray (in Parry 1928, pl. XX) further described perforated canine teeth of fox, awls, prickers or piecers, and other pointed implements as well as two pieces of bone with scoring caused by flint tools. The whereabouts of some of these artefacts is currently not known, whilst other bones described by Gray as artefacts were more likely modified by natural causes and were not implements. Parry (1931: 48, fig. 2) illustrated a 'bone awl or piercer … made from the proximal portion of a tibia of the English Varying Hare (*Lepus variabilis anglicus* Hinton) now extinct'. This specimen is also engraved by short sub-parallel incisions clustered in six groups. The engraving may have been made more apparent by the use of colorant that stained the bottom of each incision with a blackish dye, very different from the reddish colouration of the cave sediment (personal observation) (Fig. 5d).

Finally, Charles (1989) describes in great detail the 'cut-off' rib of a large mammal (likely *Equus*): 'The periosteum has been removed from the surface of the bone by longitudinal scraping whilst still "green", in preparation for carving'. The scrape marks on the specimen are abruptly interrupted at the distal end, which has been cut off from the remaining portion of the rib. Charles (1989: 403 and figs. 6, 7) interpreted this specimen (NHMUK PV Unreg 3846) as a 'drawing slate', similar to a rib engraved with a horse's head found at Robin Hood Cave in Creswell Crags, UK, which also exhibited preparatory scraping of the bone surface. While the Gough's Cave rib may have been prepared in a similar manner to the Robin Hood Cave example, it was not engraved and, instead, it was likely discarded and chewed by carnivores (Bello & Parfitt 2023) (Fig. 5e(i)). We suspect that this 'cut-off' rib could represent the discarded distal portion of a rib shaft (NHMUK PV UNREG 4190) that had been prepared, shaped, engraved on both sides, and later used as a tool (Fig. 5e(ii)).

The only limited information available on this latter specimen is reported by Hawkes, Tratman and Powers (1970). During a systematic re-examination of animal bones from

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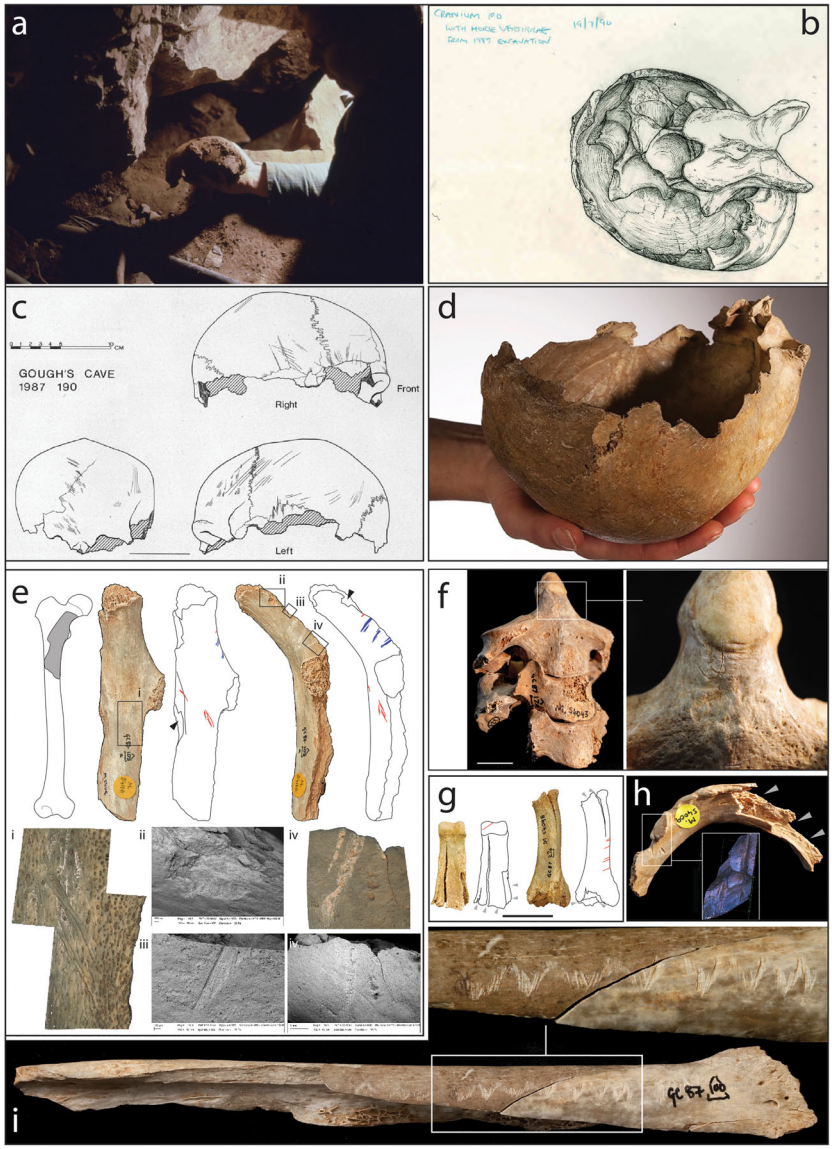

Figure 6. a-d The taphonomic history of the human calotte GC1987-190 (museum number NHMUK PAEM4134): a. Andy Currant holding the human skull during the 1987 excavation. b. Drawing of the calotte in the archaeological context, mixed with a horse vertebra and other non-human bone fragments. c. Drawing reproduced from Cook (1991: 162, fig. 15.2) with the earliest taphonomic analysis of the humanly induced modifications. d. Image of the interpretation of the calotte as a skull-cup. e. Fragment of adolescent human femur (NHMUK PAEM54116) with evidence of percussion damage (ii), cut marks (i, iii) and human chewing marks (iv). f. Human vertebrae (NHMUK PAEM54042, 54043 and 54044) with evidence of cut marks. g. Adult intermediate phalanx of the hand (NHMUK PAEM54079, left), third human metatarsal (NHMUK PAEM54144, right) and second right rib (NHMUK PAEM54009) with evidence of cut marks and human chewing marks. i. 'Zig-zag' engraving motif on shaft fragments of radius NHMUK PAEM54074. Key for e, g, f: red lines indicate cut marks, blue lines indicate human chewing scores, black arrows indicate percussion damage and grey arrows indicate crushing by human chewing. (a-b, d-1: Photos © The Trustees of the Natural History Museum, London).

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Gough's Cave in 1968, they discovered the engraved horse rib wrapped in sheets of a newspaper dated March 1958 (Hawkes *et al.* 1970: 137). They concluded that the bone was most likely found in a recess on the right side of the cave entrance, where earlier excavations had left material against the rock wall (Donovan 1955). Rosemary Powers (in Hawkes *et al.* 1970) provided a detailed description of the specimen, particularly the engravings and the presence of ochre, which she believed had been deliberately applied to the bone. She concluded that 'Primarily because of the mental laziness implied in labelling everything unexplained as a 'ritual object' the writer prefers to regard the piece of bone as a paleolithic pocket rule' (Hawkes *et al.* 1970: 141). New analysis by Claire Lucas (pers. comm. and in prep.) suggests the engraved rib may be a specialized tool, possibly a lissoir (smoother), not dissimilar from other continental Magdalenian examples.

Overall, the manufacture of both lithic and organic artefacts, as well as the engraved designs on some of these items, aligns closely with the Middle and Late Magdalenian culture. Although the skill level that can be inferred from Gough's Cave industry may not be outstanding for a Magdalenian context, the experienced working and engraving of a variety of raw materials suggest a high level of competence. The artefacts also provide further insights into the behaviours of this Magdalenian group. For example, some items, such as the perforated batons, show considerable wear, indicating that they were carried and handled over extended periods before being discarded. Additionally, the presence of the amber pebble points to long-distance transportation of artefacts and raw materials. The diversity of raw materials, artefacts, and engraved representations at Gough's Cave – comparable to those found at other European Magdalenian sites (e.g., Cook 2013; Lucas 2011; Sacchi 2003) – is unique in the British Isles. This offers valuable insights into the skills, mobility, and cultural complexity of Magdalenian groups inhabiting north-western Europe shortly before the Lateglacial Interstadial.

Fauna

The faunal remains from Gough's Cave did not receive significant scientific attention during the early stages of excavation, as the primary focus was on uncovering stalagmites and potentially discovering human remains and artefacts. For example, Davies (1904), in his report on the discovery of Cheddar Man, primarily describes and illustrates the lithic artefacts and the recovery of Cheddar Man's human remains. The faunal remains are only briefly mentioned at the end of the paper, with only a few lines devoted to their discussion: 'The animal-remains found in the cave-earth of fissure g belonged entirely to the horse; and all the hollow bones had been splintered for the marrow'. Of interest, however, is the following comment:

> The proprietor assures me that the bones and teeth of extinct mammals now placed in his collection were found in the cave-earth of the vestibule. These include *Ursus spelaeus*, *Hyaena spelaea*, *Felis spelaea*, *Rhinoceros tichorhinus*, *Cervus megaceros* (?), *Equus caballus*, etc. As, however, it is impossible to fix the exact position of these finds, I feel that the mammalian remains must not be relied upon to determine the age of the human remains found in another part of the cavern (Davies 1904: 346).

Little else is known about these early finds, many of which were likely sourced from other Mendip caves and added later to displays as a draw for visitors, as suggested by Currant (1986).

The publication by Seligman and Parsons (1914), while providing the first evidence of faunal bone artefacts at the cave, only mentions faunal remains in relation (or lack

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of) with Cheddar Man. Parry (1929*a*), nevertheless, offers greater details of the faunal assemblage, publishing the first list of species uncovered within the different layers and sub-dividing the fauna into mammals and birds (Parry 1929*a*: 104-5). Parry (1929*a*: 104) also mentions that among 'the Pleistocene remains practically all the long bones and jaws are fractured both longitudinally and transversely', hinting to the possible butchery of the carcasses by early human groups. Specimens collected in 1927-31 confirm the presence of eleven bird species, six of which can be attributed to the main Lateglacial phase of human occupation. Although not all the bird bones can be linked to the Magdalenian occupation, a few of the remains have been anthropically modified. For instance, a swan (*Cygnus cygnus*) humerus has been worked to remove blanks to make needles (Harrison 1986), and an ulna, also from a swan, was cut to make a tube (personal observation).

Andy Currant's review of these early collections, however, identified a strong bias in what was recovered and retained: 'surviving material from the 1927 to 1931 excavations bears all the hallmarks of fairly drastic selection, with a strong bias towards easily identifiable specimens, particularly teeth and foot bones' (Currant 1986: 288). This bias does not seem to have affected the more recent excavations between 1948 and 1953 by Victor Painter (Donovan 1955). Nevertheless, the loss of faunal remains seems to have continued even after the specimens were housed at museums. As noted by Currant: 'that a sizeable quantity of Gough's Cave material was periodically thrown out of the museum at Cheddar is apparent from the discovery of bones and teeth bearing characteristic spit numbers in the cave's car park in 1952' (Currant 1986: 288).

The most complete reappraisal of the fauna from Gough's Cave excavated up to 1986 has been provided by Currant (1986). He established that, despite the subdivision of layers into spits by Parry (1929*a*; 1929*b*), these characterizations did not coincide with the bedding of the cave deposits. Both the work on the fauna by Currant (1986) and on the lithics by Jacobi (2004) show that, although the finds appeared to be vertically dispersed by as much as half a metre, this apparent vertical dispersal is an artefact created by the excavation of horizontal spits cutting across the natural stratigraphy of the sediment that contained remains from a relatively short-lived, probably seasonal, Magdalenian occupation. A summer-winter occupation of the cave is also confirmed by incremental banding observed in teeth of hunted horses and deer (Beasley 1987). Indications of cold climate are provided by the presence of both Norway and Artic lemmings and saiga antelope (Currant 1987; Price 2003).

Currant (1986: 293, table II) details the complete list of mammalian species that could reliably be attributed to the Lateglacial period, with particular emphasis on the horses (*Equus ferus*), which dominate the Gough's Cave collection. Intriguing is the rarity of reindeer (*Rangifer tarandus*), a common species in the European Magdalenian landscape, but which appear to be lacking (other than the batons) for much of the main period of Lateglacial human occupation of the cave. Currant concluded that the fauna at Gough's Cave represent a coherent group of Lateglacial Interstadial mammals, supported by a fine series of closely grouped radiocarbon dates (Burleigh *et al.* 1985). The presence of a large number of bones with butchery marks also led Currant (1986) to conclude that the faunal accumulation was humanly collected during a single major phase of occupation.

The first detailed taphonomic study of the large mammal remains by Parkin, Rowley-Conwy and Serjeantson (1986) used the specific locations of cut marks and horse soft tissue anatomy to identify sinew and tendon extraction. Further taphonomic analyses

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by Andrews and Fernández-Jalvo (2003), which included the bones recovered during the more recent excavations, confirmed that the human-induced damage was the main source of taphonomic modification, while animal chewing, trampling, root-etching, weathering or diagenetic alterations only minimally affected the faunal assemblage. The high degree of fragmentation of the bones can be directly associated with butchery of the carcasses shown by the high frequencies of cut marks, percussion damage and peeling observed on the remains. All activities of butchery can be recognized in the faunal assemblage: skinning, dismembering, filleting, evisceration, tongue extraction, and marrow and grease extraction. A particularly intriguing aspect of the Gough's Cave bone assemblage is that the evidence of butchery extends to the human assemblage.

Human remains

The earliest discovery of Lateglacial human remains at Gough's Cave was made by R.F. Parry during his 1927-8 excavations, with their initial description published by Sir A. Keith and Dr. N.C. Cooper (in Parry 1929*a*). This assemblage included several cranial fragments, an almost complete child skull, a clavicle, fragments of femurs, metatarsals, metacarpals, an ilium, and a sacrum. The bones were scattered, with some fragments that were re-fitted found over two metres apart. Overall, the remains were highly fragmented, and although detailed metrical analysis was not possible, Keith described them as 'representative of a long-headed type allied to, but not so capacious nor so massive as the Cromagnon people' (Perry 1929*a*: 121).

A more comprehensive list of Upper Palaeolithic human remains was compiled by Oakley *et al.* in the *Catalogue of fossil hominids (Part II: Europe)* (1971), with these remains further described by Stringer (1985). The existing human collection, housed at the NHM, was later expanded by the discovery of additional human remains during the excavations undertaken by Currant, Jacobi, and Stringer between 1986-7 and 1989-90 (Currant *et al.* 1989) (Fig. 6a-b).

Analyses of the Magdalenian human collection were detailed in four volumes of the *Bulletin of the Natural History Museum, Geology series* between 2000 and 2003. These studies addressed various aspects of the remains, including the taphonomy of the faunal and human material (Andrews & Férnandez-Jalvo 2003), human cranial remains (Humphrey & Stringer 2002), human dental remains (Hawkey 2003), the human upper limb (Churchill 2001*a*), the human axial skeleton (Churchill 2000), and the human lower limb remains (Trinkaus 2000).

The Upper Palaeolithic human bone assemblage from Gough's Cave, housed at the NHM in London, comprises 205 identified specimens: 41 cranial pieces (37 skull fragments and four mandible fragments) and 164 postcranial fragments. Trinkaus (2001) and Churchill (2001*a*), based on analyses of lower and upper limb remains respectively, suggested a minimum number of individuals (MNI) of four. In contrast, Humphrey and Stringer (2002), examining cranial fragments, proposed an MNI of five, including a young child (aged ∼3.2 years) represented by a skull. Hawkey (2003), focusing on dental elements, argued for a minimum of seven individuals, citing a lack of clear associations among the teeth. More recently, Bello, Saladié, Cáceres, Rodríguez-Hidalgo and Parfitt (2015) proposed an MNI of six, integrating cranial and post-cranial evidence: three adults (based on three complete adult clavicles), two adolescents (identified from three unfused metatarsal bones, two from the same individual), and the 3.2-year-old child. New DNA analyses have further revised the MNI to seven individuals (Marsh & Bello 2023).

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The high level of fragmentation of the remains makes any unequivocal anatomical association for these individuals virtually impossible. However, Churchill's (2000) analysis of the human axial skeleton identified two nearly complete thoracic cages. Fifty-one rib fragments probably belonged to three distinct individuals: two smaller, possibly female individuals, and one larger, likely male. Ten vertebrae, most of which articulate with each other (Fig. 6f), could belong to a single individual. The extensive fragmentation also hampers the identification of clear morphological or morphometric characteristics for this Magdalenian group (Churchill 2000; Trinkaus 2000).

Overall, the individuals from Gough's Cave appear gracile and show no evidence of pathology, trauma, or infection. Isotope analyses suggest that the diet of this Magdalenian group did not include marine resources, and the protein intake was based predominantly on deer and horse (Marsh, 2026; Richards, Hedges, Jacobi, Currant & Stringer 2000; Stevens, Jacobi & Higham 2010).

A particularly intriguing aspect of the Gough's Cave human bone assemblage is the pervasive evidence of butchery observed on nearly all the human fragments. The hypothesis of cannibalism associated with these remains was first proposed as early as the 1930s and later expanded upon by Balch (1947). Keith and Cooper (in Parry 1929*a*: 118), commented that 'some of the skulls show fractures which were probably made when the bone was still fresh'. Likewise, Tratman (1975: 14) also suggested that the damage to the skulls was done when the bones were relatively fresh. He also commented that 'patches of red/pink staining [on the child skull] … could be the outcome of natural processes or the colour could have been humanly applied, probably the former'.

The first taphonomic analysis by Cook (1986) attributed the observed damage to largely natural causes. Conversely, Currant *et al.* (1989: 135), commenting on the newly excavated 1986-7 collection, argued that 'there is no doubt that the new collection shows evidence of human processing of parts of the body near the time of death (or at least when tissue still adhered)'. An analysis of the newly excavated assemblage led Jill Cook (1991) to conclude that the modifications observed on the human remains were of anthropic origin, indicating that the bodies had been dismembered. Cook's 1991 paper also provides some of the best illustrations of these modifications on the Gough's Cave crania, along with some of the earliest scanning electron microscope (SEM) images of the cut marks (Fig. 6c).

Andrews and Fernández-Jalvo's (2003) taphonomic analyses of both human and non-human remains made a compelling case for the presence of 'nutritional cannibalism' at Gough's Cave, based mainly on the mixing of human remains with other faunal remains and the similarity of the butchery processes. The authors also describe the presence of human chewing marks on some of the human bones of the hands and feet (Fernández-Jalvo & Andrews 2011) (Fig. 6g). Moreover, the authors noted differences in the preservation of the human skulls, which appeared better preserved and less fragmented compared to the post-cranial remains. Bello, Parfitt and Stringer (2011*a*) further investigated the cranial modifications, concluding that the skulls had been carefully cleaned of any soft tissue and deliberately broken through with careful chipping to create skull cups (Fig. 6a-d).

Cut marks and scratches on the teeth were initially identified by Bello, Verveniotou, Cornish and Parfitt (2011*b*), and later studied in detail by Crété, Parfitt, Day and Bello (2024), who observed two types of scratches. Cut marks on the posterior dentition, which are deeper and wider than any other scratch observed on the human teeth, have been described as the result of activities such as the post-mortem defleshing and

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cutting of the masseter muscle of cadavers during cannibalistic practices. A second set of non-masticatory labial striations were observed on the anterior teeth. These marks, shallower and with an oblique orientation, have been interpreted as evidence that the mouth was used as a 'third hand' during daily activities, such as cutting meat or processing hides with stone tools.

In a more detailed analysis of the human assemblage, Bello *et al.* (2015) documented the complete butchery process, including evidence of scalping, intensive cleaning of the bones to remove soft tissue, the fracturing of bone shafts to extract marrow, the consumption of spongy bone, and the presence of human chewing marks on several human bones (Fig. 6e-h). Further research by Bello, Wallduck, Dimitrijević, Živaljević and Stringer (2016) involved micro-morphometric analysis of humanly induced modifications, and comparisons of the modifications between cannibalized assemblages with other human assemblages where bodies had been defleshed but not consumed. This study reinforced the conclusion that cannibalism occurred at Gough's Cave by demonstrating that the frequency, location, and the micro-morphometric characteristics (depth and width of cuts according to individual body mass) of cut marks on human and non-human remains produced when cleaning partially decayed bodies are significantly different from cut marks produced during butchery of fresh bodies (Bello *et al.* 2016; Wallduck & Bello 2018).

One human bone, in particular – a right human radius (NHMUK PV M54074) – has received contentious interpretations. Excavated in 1987, this specimen displays cut marks, percussion damage, human tooth marks, and a series of unusual zig-zagging incisions along the lateral side of the diaphysis (Fig. 6i). These marks were initially interpreted as engravings by Churchill (2001*a*), but later dismissed as filleting marks by Andrews and Fernández-Jalvo (2003) and Fernández-Jalvo and Andrews (2016), who classified them as marks produced during butchery. However, Bello, Wallduck, Parfitt and Stringer (2017) revisited the earlier interpretation based on new macro- and micro-morphometric analyses of the incisions, and comparisons of the motif on the radius to engraved Magdalenian artefacts found across Europe. They concluded that the modifications are, in fact, intentional engravings, possibly associated with a cannibalistic ritual.

However, the question remains: was cannibalism practised at Gough's Cave out of choice or necessity? Was the cave used as a funerary site, as Roger Jacobi (2004) suggested, where ritualistic cannibalism occurred (as proposed by Bello and colleagues 2011*a*; 2015; 2017), or was it a site where nutritional cannibalism was practised (Andrews & Fernández-Jalvo 2003)? Could it even have been a place where cannibalism was forced upon humans due to starvation? A review of the ways human bodies were disposed of across Europe during the Magdalenian may help answer these questions.

Marsh and Bello (2023) catalogued fifty-nine sites with human remains attributed to the Magdalenian period, identified based on radiocarbon dating or association with Magdalenian lithic or bone industries. Twelve of these sites featured burials, mostly individual single burials. However, fifteen Magdalenian sites across Europe, including Gough's Cave, contain evidence of cut-marked and modified human remains, often interpreted as evidence of cannibalism. At these sites, cranial fragments are frequently over-represented, and at least six assemblages show evidence of post-mortem manipulation of the cranial vault, which has been associated with the manufacture of skull-cups. These sites include Le Placard, Isturitz, and Courbet Cave in

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France; El Castillo Cave in Spain; Gough's Cave in the UK; and possibly Brillenhöhle in Germany (Bello & Créte 2025; Bello *et al.* 2011*a*; Boulestin & Gambier 2012; Gambier 1992; Maginedas *et al.* 2020; Orschiedt 2013). Engraving of human remains linked to cannibalism was also identified at Gough's Cave (Bello *et al.* 2017) and suggested for Isturitz (Buisson & Gambier 1991). The manipulation of human bodies beyond the act of cannibalism, especially given its recurring appearance within Magdalenian culture, points to this practice being widespread and likely an established customary behaviour. This strongly suggests that cannibalism in these contexts was ritualistic in nature (Bello 2025).

The review by Marsh and Bello (2023) also identified a connection between funerary practices and genetic ancestry. Although based on archaeological and genetic evidence from only eight Magdalenian sites and two Epigravettian sites, Marsh and Bello (2023) established that individuals with Goyet Q2 ancestry (associated with Magdalenian groups) were found exclusively in cannibalistic funerary contexts, while those with Villabruna ancestry (linked to Epigravettian groups) were found only in primary burial contexts. While additional analysis on a larger scale is necessary to confirm these preliminary results, the association between funerary practices and genetic ancestry suggests that complex cultural beliefs, such as ritualistic cannibalism, may have helped reinforce social identities and group segregation or isolation. Consequently, genetic studies may offer valuable insights into the cultural practices of these ancient populations.

Discussion and conclusions

Over the past 125 years, Gough's Cave has played a pivotal role in transforming our understanding of the Mesolithic and Late Upper Palaeolithic periods. The discovery in 1903 of Cheddar Man, an almost complete Mesolithic skeleton, has provided invaluable insights into one of the oldest known Holocene (postglacial) humans in Britain. Ancient DNA analysis (Brace *et al.* 2019) has revealed that Cheddar Man possessed genetic markers for dark hair and skin pigmentation, traits typically associated with sub-Saharan Africans, alongside light-coloured eyes, either blue or green, a characteristic found in several other Mesolithic human remains across Europe. The hunter-gatherer population to which Cheddar Man belonged was largely supplanted by farming communities that later migrated into Britain. As a result, modern British people are not direct descendants of Cheddar Man but share approximately 10% of their genetic ancestry with the European population to which he belonged (Brace *et al.* 2019).

Even more distant genetic links connect modern-day British people to the Late Upper Palaeolithic population of Gough's Cave. The genetic data obtained for the Upper Palaeolithic human collection from Gough's Cave (Charlton *et al.* 2022) represent the oldest human DNA yet recovered from the British Isles. The individuals from Gough's Cave trace their genetic (Goyet) ancestry to Magdalenian groups that inhabited Europe, ranging from Poland in the east to France and Spain in the south-west. The high mobility of these Magdalenian groups is further evidenced at Gough's Cave by the presence of exotic raw materials, such as an amber fragment, which may have been sourced over 300 kilometres away. The wealth of human and faunal remains, along with artefacts and engraved objects uncovered at Gough's Cave, is unique to the British Isles and provides an important piece of the puzzle in understanding the cultural complexity and adaptability of Magdalenian populations who colonized northern territories towards the end of the Last Glacial.

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The analysis of Magdalenian human remains at Gough's Cave has not only unequivocally confirmed that cannibalism was practised at the site, but also provided the first compelling evidence that cannibalism was part of a complex ritualistic behaviour. The combination of taphonomic and genetic analyses of Late Upper Palaeolithic human remains across Europe, driven by the re-examination of the Gough's Cave assemblage, has for the first time established an association between funerary practices and population genetic ancestry. Preliminary analyses (Marsh & Bello 2023) have shown that genetically sequenced Late Upper Palaeolithic human remains from cannibalized contexts, including those from Gough's Cave, exclusively exhibit Goyet Q2 ancestry, typically linked with Magdalenian culture. In contrast, individuals found in primary burial contexts carry Villabruna ancestry, associated with Epigravettian culture. This marks the first instance where an association between prehistoric funerary practices and genetic ancestry has been established. If future studies confirm the hypothesis linking funerary behaviour to genetic ancestry, it could have significant implications for how we interpret interactions between populations. Such a link might suggest that complex burial practices played a role in cementing social identities and fostering segregation between different groups.

The collections from Gough's Cave are not only crucial evidence for advancing our understanding of Mesolithic and Upper Palaeolithic cultures and populations in Europe, but they have also served as a testing ground for the development of new analytical techniques. Innovative radiocarbon, isotope and ancient DNA methods, and cutting-edge microscopy approaches (e.g., SEM, 3D microscopy, CT scanning) were trialled on faunal and human collections from Gough's Cave. The interpretation of these finds – such as the reconstruction of Cheddar Man as a dark-skin blue-eyed individual, the evidence of cannibalistic behaviour or how artefacts were used – has sparked thought-provoking debates, some of which continue to this day.

It will come as no surprise that the authors believe the collections from Gough's Cave still have much to reveal. Some materials, such as certain artefacts, would benefit from a fresh examination using more contemporary analytical techniques to better understand how they were made and used. Genetic analysis of the Magdalenian human collection could potentially allow determining family kinships among the different individuals. Genetic analysis of the faunal collections could also open new avenues, including the intriguing possibility of the presence and domestication of dogs at the site. Finally, the authors hope to identify the location where the over 500 tons of sediment were disposed of by the Gough family in the early 1900s. Excavating these missing sediments could significantly enhance the research potential of the site. The existing faunal, human, and artefact collections have already been intensively sampled for dating, isotopes, and ancient DNA, making them an increasingly limited resource. However, recovering additional artefacts, human remains, and butchered animal bones discarded in Gough's spoil heaps would greatly increase the scientific value of the site, further cementing Gough's Cave as one of Europe's most important archaeological sites. If those sediments were ever to be found, we believe Gough's Cave could continue to yield valuable insights for at least another 125 years.

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125 ans d'exploration et de recherches à Gough's Cave (Somerset, Royaume-Uni)

Résumé

Les découvertes faites à Gough's Cave (Somerset, Royaume-Uni) ont largement contribué à notre compréhension de la recolonisation du nord-ouest de l'Europe au cours de la période qui a précédé le Tardiglaciaire. Cette grotte est le site du Paléolithique supérieur tardif le plus riche des îles Britanniques et a livrée un assortiment exceptionnel de vestiges humains, d'artefacts lithiques et organiques et de restes d'animaux découpés pour la consommation. Les vestiges humains ont pour particularité singulièrement

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intrigante de montrer des traces de découpe, notamment d'enlèvement étendu des parties molles, de fracture des os longs en vue d'en extraire la moelle, de mastication et de consommation d'os spongieux. On a retrouvé, en outre, des crânes humains transformés en coupes et une diaphyse radiale gravée, qui suggèrent que le cannibalisme revêtait un caractère rituel. Après cette activité brève mais intense au Paléolithique supérieur tardif, il semble que le site ait été largement abandonné par les populations préhistoriques postérieures. On ne peut donc que s'étonner d'y avoir découvert le squelette presque complet d'un homme du Mésolithique, dont on ne sait pas bien s'il a été enterré intentionnellement à cet endroit ou s'il y est mort. L'ADNa de cet homme montre qu'il descendait de chasseurs-cueilleurs d'Europe occidentale, distincts à la fois des Magdaléniens antérieurs dont les restes ont été retrouvés sur le site et des colons ultérieurs du Néolithique. Le présent article retrace l'histoire de l'exploration et des recherches menées à Gough's Cave au cours des 125 dernières années.

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