Quaternary of South-West England

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CHAPMAN & HALL

Chapter 5

Pleistocene cave sequences

INTRODUCTION
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South-West England contains some of the most important Pleistocene cave sequences in Britain. The Carboniferous Limestone of the Somerset and Avon districts (particularly the Mendips), and the Devonian limestones of south Devon (Figures 2.1 and 5.1), host numerous caves and cave systems, many of which contain important sediment sequences, faunal remains and artefacts. As a result, the caves have long attracted scientific interest and several locations remain the subject of intensive modern research. This chapter reviews evidence from four of the stratigraphically most significant localities – Kent's Cavern (Torquay), Tornewton Cave (Torbryan), Chudleigh Caves and Joint Mitnor Cave (Buckfastleigh).

The importance of the region for Pleistocene cave studies stems from a number of circumstances. First, the region was situated overwhelmingly, if not entirely, beyond the southern limits of Pleistocene glaciation (Figure 2.3), and lay centrally in a zone across which a whole range of Pleistocene mammal species would have migrated in response to climatic and environmental changes (Sutcliffe, 1969; Cullingford, 1982).

Second, the Devonian and Carboniferous limestones of the region exhibit significant karst development, providing a profusion of suitable caves, fissures and shafts where sediments, faunal remains and artefacts have accumulated by a variety of agencies. In some locations, animals fell into caves via open shafts and became trapped (e.g. Joint Mitnor Cave and Banwell Bone Caves; Cullingford, 1953; Sutcliffe, 1960; Macfadyen, 1970); other locations were used as natural refuges or dens, for example by bears or hyaenas, in which the animals died, leaving their own remains as well as those of their prey (e.g. Tornewton Cave; Sutcliffe and Zeuner, 1962; Sutcliffe, 1974). Occasionally, fossil bones are preserved in cave stream deposits (e.g. Eastern Torrs Quarry Cave, near Plymouth; Sutcliffe, 1969, 1974). Particularly significant are the remains of rodents, which evolve more quickly than the larger mammals and which can provide important palaeoenvironmental evidence (Sutcliffe, 1974; Sutcliffe and Kowalski, 1976). Bone preservation, even of microfaunal remains, has been aided in many circumstances by alkaline conditions. Thirdly, the South-West, and Devon in particular, was the scene for much of the pioneering work carried out in the nineteenth century.

Geological Conservation Review site selection

The large numbers of caves and fissures in South-West England where sediments, faunal remains and artefacts have been described, provide significant difficulties with respect to selecting the 'best' or most appropriate sites for conservation. Following the guidelines outlined in Chapter 2 (Ellis *et al.*, 1996), four sites believed to contain the most important stratigraphical and palaeoenvironmental evidence (and with some of the most extensive histories of research) were selected, and are described in this volume (this chapter). A further five sites in Somerset and Avon (Sun Hole (Cheddar Complex); Bridged Pot and Savory's Hole (Ebbor Gorge); Badger Hole and Rhinoceros Hole (Wookey Hole); Picken's Hole and Beeche's Hole (Crook Peak–Shute Shelve Hill); Banwell Bone Caves) are to be described in a separate volume of the GCR Series – *Fossil Mammals and Birds* (in prep.) – in the *Pleistocene Vertebrata* section. Tornewton Cave and Joint Mitnor Cave (this volume; Chapter 5) and Brean Down (this volume; Chapter 9) are described again in the latter volume by virtue of their palaeontological importance, which was assessed independently.

The caves of south Devon

The south Devon caves have been studied for nearly 200 years (e.g. Polwhele, 1797). In fact, the first bone cave to be studied scientifically in Britain was excavated by Joseph Whidbey at Oreston, near Plymouth, in 1816 (Sutcliffe, 1969; Cullingford, 1982). In 1825, the Reverend J. MacEnery began his excavations at Kent's Cavern, later to be continued by William Pengelly (e.g. Pengelly, 1868b, 1869, 1871, 1878, 1884). William Buckland also visited many of the Devon caves during the 1820s, including Kent's Cavern, Pixie's Hole (Chudleigh), Oreston and Anstey's Cove Cave among others (Figure 5.1; Sutcliffe, 1969). Importantly, Pengelly's excavations in the Brixham Cave in 1859 provided the first published account to demonstrate that humans had occupied the region before the extinction of the cave mammals, a fact later to be reinforced by his work in Kent's Cavern (note also the work of MacEnery; this chapter) (Sutcliffe, 1969).

Of the early excavations, J.L. Widger's in the Torbryan Caves from about 1865 to 1880, are particularly notable. From the 1920s until the

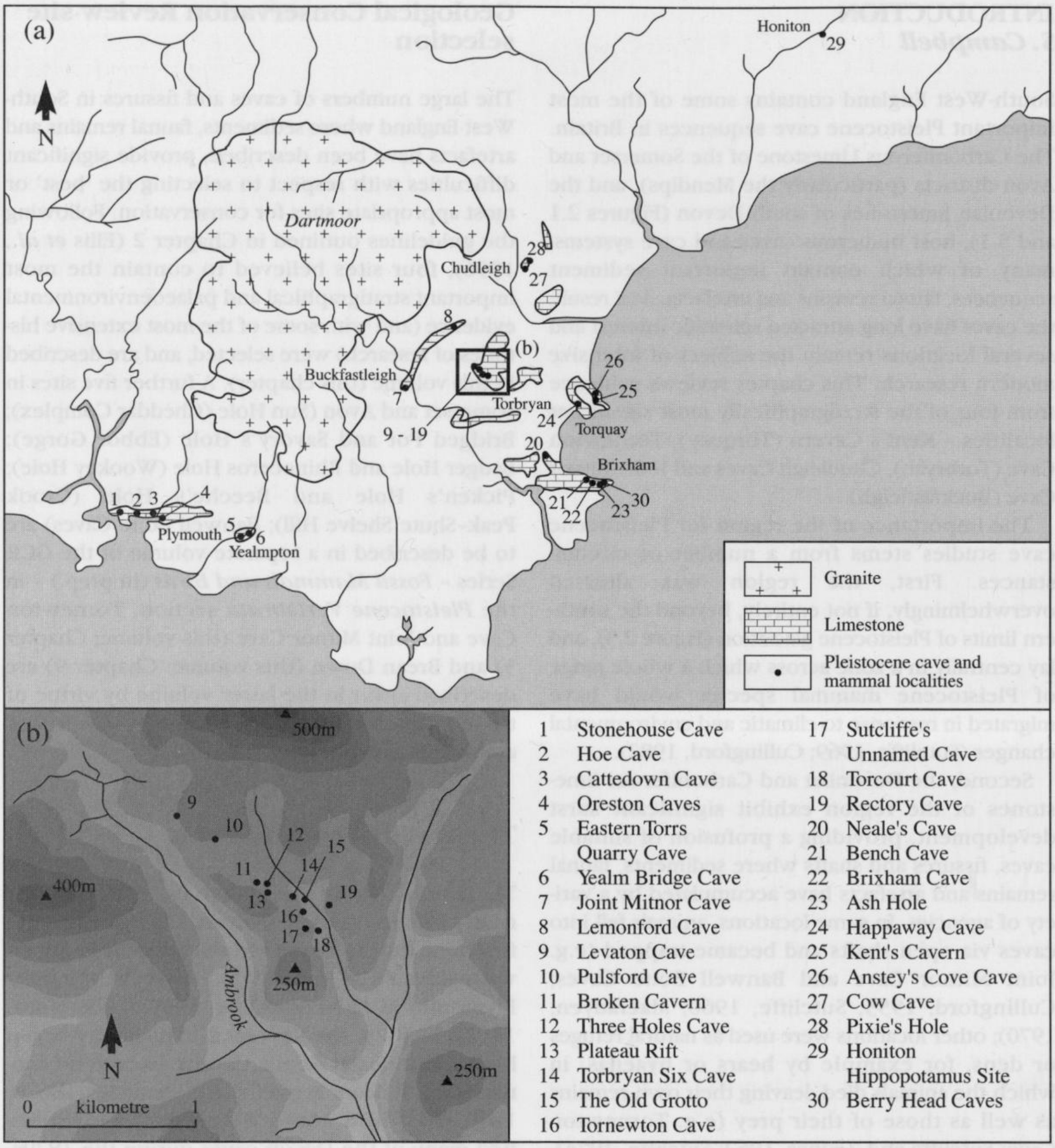

Figure 5.1 (a) The principal localities where remains of Pleistocene mammals have been found in Devon, after Sutcliffe (1969). (b) Excavated caves in the Torbryan Valley, after Roberts (1996). The location of Berry Head 'sea caves' (Proctor, 1994, 1996) is also shown.

beginning of World War Two, the Torquay Natural History Society excavated in Cow Cave (Chudleigh), Kent's Cavern, Tornewton Cave and Joint Mitnor Cave. Since the War, excavations have been carried out by Almy, Cheesman, Neale, Rosenfeld, Sutcliffe, Zeuner and others in Tornewton, Three Holes and Levaton caves (Torbryan); Joint Mitnor Cave; Eastern Torrs Quarry Cave, Yealmpton (discovered by quarrying in 1954); and Neale's Cave, Paignton (discovered in 1958) (Sutcliffe, 1969, 1974, 1977).

The principal localities where remains of Pleistocene mammals have been found in south Devon are shown in Figure 5.1. With the exception of the Honiton hippopotamus site, where a peat deposit with an Ipswichian fauna was excavated during roadworks in 1964 (Turner, 1975), the caves are all located in Devonian limestone below *c.* 100 m OD (Sutcliffe, 1969, 1974, 1977).

Kent's Cavern, Tornewton Cave and Joint Mitnor Cave have long been regarded as the most important sites, both stratigraphically (in terms of length and detail of palaeoenvironmental record) and palaeontologically. However, Chudleigh Caves also contain significant sediment sequences, fossils and artefacts which have been investigated systematically by Collcutt (1984, 1986); Pixie's Hole is particularly notable in containing the greatest demonstrable extent of Later Upper Palaeolithic deposits surviving in any known British cave site (Collcutt, 1996). Recent Uranium-series work on speleothem in the Berry Head Caves (Figure 5.1) confirms their potential for calibrating marine Pleistocene events (Proctor and Smart, 1991; Baker, 1993; Proctor, 1994; Baker and Proctor, 1996) and necessitates their future assessment for GCR status.

Kent's Cavern is a site of considerable historical importance in British Pleistocene studies (e.g. Pengelly, 1884; Campbell and Sampson, 1971; Proctor and Smart, 1989; Proctor, 1994). It contains a sequence of sediments, with fossil fauna and artefacts, which extends well back into the Middle Pleistocene. The interpretation of the sequence has been hampered both by Pengelly's removal of most of the cave sediments and by an inability, until recently, to date the earliest deposits in the cave: the latter have appeared to most workers to be significantly older than deposits in the upper part of the sequence. Some have speculated that the controversial Breccia, with its *Ursus deningeri* von Reichenau fauna (with *Homotherium latidens* Owen), could date from the Cromerian Complex (e.g. Hinton, 1926; Campbell and Sampson, 1971; Sutcliffe and Kowalski, 1976; Straw, 1983), but recent Uranium-series and Electron Spin Resonance (ESR) dates associated with the breccia (Proctor, 1994, 1996) suggest an age of *c.* 300–400 ka BP for the deposit, and a possible correlation with Oxygen Isotope Stages 9 or 11 of the marine record. Proctor's work, however, confirms earlier views that the Crystalline Stalagmite represents a lengthy hiatus between deposition of the Breccia and the overlying Cave Earth. Controversially, Straw (1995, 1996) has suggested that the Crystalline Stalagmite was broken up by an earthquake. The traditional interpretation of the Cave Earth as a Devensian deposit is upheld by U-series dates which invite a correlation with Oxygen Isotope Stages 4 to 2: the deposit contains a typical and diverse Devensian mammal fauna dominated by spotted hyaena, which evidently used the cave as a den (Proctor, 1994, 1996).

Tornewton Cave, in the Torbryan Valley (Figure 5.1), is of considerable importance for a sequence of richly fossiliferous deposits spanning the entire Late Pleistocene and extending well back into the Middle Pleistocene (Roberts, 1996). Sutcliffe and Zeuner (1962) interpreted the sequence as an Ipswichian interglacial layer (Hyaena Stratum) sandwiched between Saalian (Glutton Stratum) and Devensian (Reindeer Stratum) cold-climate deposits, and this view has since been reiterated in a number of publications and wider correlations (e.g. Sutcliffe, 1969, 1974, 1977; Stephens, 1973). Recent multi-disciplinary work, sponsored by the British Museum between 1989 and 1992 at Torbryan, has confirmed the palaeoenvironmental value of the caves, especially Three Holes Cave, Broken Cavern and Tornewton Cave, and led to considerable re-evaluation and elaboration of the sequences (e.g. Proctor, 1994; Barton, 1996; Berridge, 1996; Cartwright, 1996; Caseldine and Hatton, 1996; Currant, 1996; Debenham, 1996; Gleed-Owen, 1996, 1997; Irving, 1996; Price, 1996; Proctor and Smart, 1996; Seddon, 1996; Stewart, 1996). Although the full results of the Torbryan Caves Research Project await publication (Roberts *et al.*, in prep.), it is likely that the sequence at Tornewton Cave spans from Oxygen Isotope Stage 7 (Otter Stratum), through Stage 6 (minor debris flow), to the warmest parts of Stage 5 (Bear Stratum, Hyaena Stratum and 'Dark Earth') to Stage 4 (isolated deposits with a *Rangifer* and *Bison* fauna) and Stage 3 (material at the cave mouth) to Stage 2 (Glutton Stratum – a huge mass-flow deposit), thus providing one of the most complete Pleistocene cave sequences known in Britain.

Although a comparable reappraisal of the sequence at Joint Mitnor Cave at Buckfastleigh is not available, the site remains one of the most important localities for Ipswichian mammal remains in Britain (Stuart, 1982b), and is included in this volume on that basis.

The caves of Somerset and Avon

The Carboniferous Limestone of the Bristol, Bath and Mendip areas hosts a significant number of caves, fissures and shafts which contain Pleistocene sediments, fossils and artefacts (e.g. Balch, 1947, 1948; Donovan, 1954, 1964; Ford, 1968; Macfadyen, 1970; Drew, 1975; Campbell, 1977; Hawkins and Tratman, 1977; Irwin and Knibbs, 1987; Waltham *et al.*, 1996). The caves have long been the subject of scientific study, but overwhelmingly (with the notable exception of Westbury-sub-Mendip) the evidence dates largely from the Devensian Stage, particularly Oxygen Isotope Stages 4 and 2, and does not provide a sufficient length or detail of palaeoenvironmental record to have merited selection within the subject 'blocks' of the GCR described in this volume (Chapter 2). However, a number of the Somerset and Avon cave sites are of considerable palaeontological significance, and are thus described elsewhere in the GCR Series of volumes (see above; Geological Conservation Review site selection). Excellent reviews, with comprehensive bibliographies, of the cave and fissure deposits of these areas are provided by Donovan (1954, 1964), Macfadyen (1970) and Hawkins and Tratman (1977), and only brief background comments are provided here on the more significant localities for Pleistocene studies.

The longest and most significant record from this region comes from Westbury-sub-Mendip, where a fossil mammal fauna (Westbury 1 fauna) may provide evidence of conditions in Cromer-Complex times (Heal, 1970; Bishop, 1974, 1982; Stringer *et al.*, 1996). The later Westbury faunas (Westbury 2 and 3 faunas) appear to be post-Cromerian (cf. West Runton) but pre-Hoxnian *sensu stricto* (Stringer *et al.*, 1996), and thus represent an important part of the Pleistocene record only poorly known elsewhere in the region. Historically, the Westbury deposits have proved difficult to conserve effectively, although the site's adjacent karstic features are included within a GCR site selected for the 'block' *Karst and caves of Great Britain* (Ellis *et al.*, 1996; Waltham *et al.*, 1996). Continuing use of the locality for stratigraphic and palaeontological studies, however, undoubtedly warrants reconsideration of its GCR status for the site 'blocks' – *Quaternary of South-West England* and *Quaternary of Somerset and Avon* – described in this volume, and also for the *Pleistocene Vertebrata* section of the GCR.

Evidence for conditions in the Ipswichian Stage comes from relatively few cave localities in Somerset and Avon (Chapter 2; Ipswichian Stage). Particularly significant are the sequences at Badger Hole and Rhinoceros Hole (Wookey). The former contains *in situ* deposits which contain mammal remains of Middle and Late Devensian (pre-Devensian late-glacial) age in association with Early Upper Palaeolithic artefacts. Significantly, Rhinoceros Hole contains a sequence of deposits containing a characteristic Ipswichian interglacial fauna including hippopotamus, as well as younger deposits with contained faunas probably dating from the Middle Devensian (Stuart, 1982b).

Banwell Bone Caves are significant for having yielded a rich Pleistocene bone assemblage, mainly bison and reindeer (Balch, 1948; Cullingford, 1953; Macfadyen, 1970; Stuart, 1982b). Like Joint Mitnor Cave in south Devon, the animals here appear to have fallen to their deaths through a large hole in the cave roof. Extensive deposits remain *in situ*, but further work is necessary to establish the age and full composition of the fauna, and the stratigraphical relationships of deposits within the cave (Stuart, 1982b).

Bridged Pot, in the Ebbor Gorge, is notable for one of the best (presumed) Late Devensian small-mammal assemblages in Britain (Stuart, 1982b). The fauna from this small cave includes steppe pika *Ochotona pusilla* Pallas, arctic lemming, Norway lemming, various voles, red deer and reindeer: largely undisturbed deposits at nearby Savory's Hole are likely to yield a similar assemblage (Stuart, 1982b).

Picken's Hole (Crook Peak–Shute Shelve Hill) is of considerable importance for its clear, well-stratified sequence of deposits and faunas, all dating from within the Devensian Stage. The rich 'Layer 3' fauna (radiocarbon dated to 34 265 + 2,600/− 1,950 BP) includes spotted hyaena, lion, arctic fox, mammoth, woolly rhinoceros, horse, reindeer, suslik and northern vole *Microtus oeconomus* (Pallas), and provides a major source of information for the Middle Devensian. It is also notable for being the most carefully excavated hyaena-den site in Britain (Stuart, 1982b). The nearby Beeche's Hole is likely to contain deposits and faunal remains of comparable age (Stuart, 1982b).

Sun Hole, Cheddar, provides a varied fauna which has been radiocarbon dated to the end of the Late Devensian. The fauna includes both arctic and Norway lemming, various voles, steppe pika, brown bear, wolf, horse, reindeer and, of particular interest, saiga antelope – the only well-dated record of this species in Britain (Stuart, 1982b).

KENT'S CAVERN

D. H. Keen

Highlights

Kent's Cavern contains a wide range of Quaternary deposits, the earliest of which date from the Middle

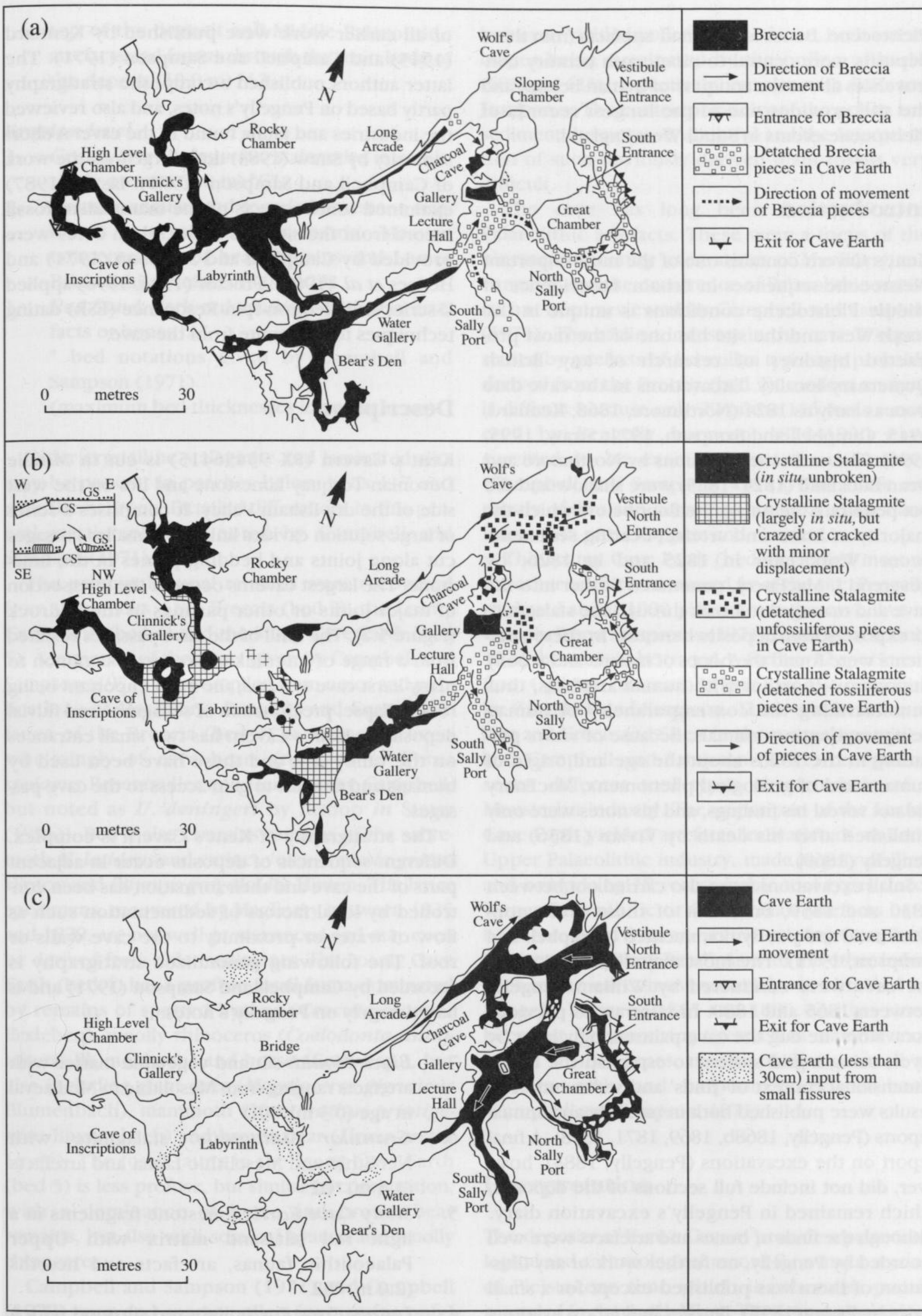

Figure 5.2 Kent's Cavern, after Straw (1996). Distribution of: (a) Breccia; (b) Crystalline Stalagmite; (c) Cave Earth. (a)–(c) are shown as indicated in Reports to the British Association by W. Pengelly, 1865–1880. Cave outline is based on the survey by Proctor and Smart (1989).

Pleistocene. Bones and human artefacts from these deposits were central to nineteenth century controversies about the antiquity of human beings, and the site provides one of the longest records of Pleistocene events in South-West England.

Introduction

Kent's Cavern contains one of the most important Pleistocene sequences in Britain. Its evidence of Middle Pleistocene conditions is unique in the South-West and the site has one of the most protracted histories of research of any British Quaternary locality. Excavations in the cave date from as early as 1824 (Northmore, 1868; Kennard, 1945; Campbell and Sampson, 1971; Straw, 1995, 1996). The earliest excavations by Northmore and Dean Buckland (1824–1825) were shallow and did not penetrate the stalagmite floor below which the majority of bone- and artefact-bearing sediments occur. Work later in 1825 and in 1826, by Reverend J. MacEnery, penetrated farther into the cave and managed to break through the stalagmite to expose softer deposits beneath. In these sediments were found the bones of hyaena and woolly rhinoceros, together with human artefacts, thus demonstrating the contemporaneity of human beings and extinct animals. Because of views prevailing in the 1820s about the age and origin of humans and of geological phenomena, MacEnery did not reveal his findings, and his notes were only published after his death by Vivian (1856) and Pengelly (1869).

Small excavations were also carried out between 1830 and 1850, but most of these were nonsystematic and poorly documented (Campbell and Sampson, 1971). The most major excavations in the cave were conducted by William Pengelly between 1865 and 1880. In contrast to previous excavators, he dug the cave painstakingly layer by layer, using a grid system to establish the three-dimensional context of 'finds' and sediments. The results were published both in monthly and annual reports (Pengelly, 1868b, 1869, 1871, 1878). A final report on the excavations (Pengelly, 1884), however, did not include full sections of the deposits, which remained in Pengelly's excavation diary. Although the finds of bones and artefacts were well recorded by Pengelly, no further work or any illustration of them was published except for a small series by Evans (1897). Further limited excavations were conducted in the 1920s and 1930s (Dowie, 1928; Beynon *et al.*, 1929; Smith, 1940). Reviews of all earlier work were published by Kennard (1945) and Campbell and Sampson (1971). The latter authors published a composite stratigraphy partly based on Pengelly's notes, and also reviewed the industries and fauna found in the cave. A short summary by Straw (1983) drew largely on the work of Campbell and Sampson (1971). Lister (1987) examined some aspects of the mammalian fossil record from the site and radiocarbon dates were provided by Campbell and Sampson (1971) and Hedges *et al.* (1989). Proctor (1994, 1996) applied U-series and Electron-spin Resonance (ESR) dating techniques to stalagmite from the cave.

Description

Kent's Cavern (SX 93456415) is cut in Middle Devonian Torquay Limestone and lies on the west side of the dry Ilsham Valley. It comprises a series of large solution cavities linked by smaller passages cut along joints and bedding planes in the limestone. The largest caverns occur at the intersection of major joints or other partings in the bedrock (Figure 5.2). The infill of the cave passages resulted from a range of interlinked processes common to many karst cave systems, the most important being roof collapse, precipitation of stalagmite and fluvial deposition. Kent's Cavern has two small entrances on the valley side and these have been used by humans and animals to gain access to the cave passages.

The stratigraphy of Kent's Cavern is complex. Different sequences of deposits occur in adjacent parts of the cave and their formation has been controlled by local factors of sedimentation such as flow of water or proximity to the cave walls or roof. The following generalized stratigraphy is recorded by Campbell and Sampson (1971) and is based largely on Pengelly's notes:

7. *Black Mould*: silt and vegetable matter with artefacts ranging from Mesolithic to Mediaeval in age (0.3 m) *F/D
6. *Granular Stalagmite*: stalagmite with Neolithic and Mesolithic fauna and artefacts (1.5 m) *C2
5. *Stony Cave Earth*: limestone fragments in a light red silt/sand matrix with Upper Palaeolithic faunas, artefacts and hearths (2.0 m) *B2
4. *Loamy Cave Earth*: light red silt/sand with a few limestone fragments, some rounded. Upper Palaeolithic artefacts and faunas in the

top of the deposit and Middle Palaeolithic artefacts and faunas through the main body of the deposit (10.0 m) *A2

Erosion level

3. *Crystalline Stalagmite*: stalagmite intermittently present (4.0 m) *C1
2. *Breccia*: angular and rounded limestone fragments in a red sand/silt matrix. Massive concentration of bear remains and Lower Palaeolithic artefacts (3.0 m) *B1
1. *Red Sand*: dark red sand/silt with few artefacts or bones *A1

* bed notations given by Campbell and Sampson (1971)
(maximum bed thicknesses in parentheses)

Older crystalline stalagmite and laminated silts may be present in patches below beds 1–7 and over the bedrock. Detailed differences in this general stratigraphy are noted by Campbell and Sampson (1971).

The principal faunal remains were recovered from three units – the Breccia (bed 2), the Loamy Cave Earth (bed 4) and the Stony Cave Earth (bed 5). A summary of the fauna given by Campbell and Sampson (1971) was compiled from notes and publications of MacEnery, Pengelly and Evans. The fauna of the Breccia (bed 2) is composed overwhelmingly of cave bears (referred to *Ursus spelaeus* Rosenmüller and Heinroth by Campbell, but noted as *U. deningeri* by Bishop *in* Straw (1996)). Bed 2 also contains remains of the sabretooth *H. latidens* and extinct voles *Arvicola greeni* Hinton and *Pitymys gregaloides* Hinton. The latter specimens, recovered by MacEnery between 1825 and 1829, are not well provenanced and may even be derived from older sediments. The Loamy Cave Earth (bed 4) has a profuse fossil fauna dominated by remains of spotted hyaena (*Crocuta crocuta* Erxleben), woolly rhinoceros (*Coelodonta antiquitatis* Blumenbach) and horse (*Equus* sp.), but also including giant deer (*Megaloceros giganteus* Blumenbach), mammoth (*Mammuthus primigenius* Blumenbach) and brown bear (*Ursus arctos* Linné). The fossil fauna in the Stony Cave Earth (bed 5) is less profuse, but similar in composition, with a dominance of horse and brown bear remains, but also with some of hyaena and woolly rhinoceros.

Campbell and Sampson (1971) and Campbell (1977) recorded sparse pollen (two grains only) from the basal Red Sand (bed 1). The Loamy Cave Earth (bed 4) and the Stony Cave Earth (bed 5), however, yielded pollen in abundance, both assemblages being dominated by the pollen of herbs (68% and 61%, respectively) but also with *Salix* and *Juniperus*. The contemporaneity of the pollen and sediment, however, is doubtful and the interpretation of such obviously derived plant fossils very difficult.

The cave has long been famous for its Palaeolithic artefacts. These were a focus of the nineteenth century excavations of MacEnery and Pengelly, and the occurrence of Palaeolithic material has been reviewed by Campbell and Sampson (1971). The earliest industry in the cave is represented by artefacts of Acheulian typology, probably derived from the Breccia (bed 2): modern analysis is difficult because only 29 of the 116 tools recovered by Pengelly between 1872–1900 have survived to be examined by recent workers (Campbell and Sampson, 1971). The tools are mostly of flint and consist of crude hand-axes and flakes with rare choppers and cleavers.

The Loamy Cave Earth (bed 4) yielded most of the other artefacts recovered from the site. Pengelly retrieved about 1000 pieces from the cave, but in Campbell and Sampson's (1971) reassessment only 33 of these could be traced. A further 12 specimens from Ogilvie's excavation (1926) are also described by Campbell and Sampson. These artefacts are of flint and Greensand Chert in about equal quantities, and Campbell and Sampson (1971) recognized seven different tool types characteristic of a Mousterian industry. The upper part of the Loamy Cave Earth yielded artefacts indicative of an Early Upper Palaeolithic industry, made largely of flint, and comprising 18 recognizable tool types. Later Upper Palaeolithic or Creswellian artefacts have been recovered from a level in the Stony Cave Earth known as the 'Black Band'. As with the other industries in the cave, most material was obtained by Pengelly between 1865 and 1880, and has since been lost. The surviving Creswellian material comprises 16 tool types, mostly of flint, as well as needles, awls and harpoon points of bone (Campbell and Sampson, 1971).

Interpretation

The deposits of Kent's Cavern provide a palaeontological and archaeological record for a major section of Pleistocene time which is otherwise poorly recorded in the South-West. The faunal assemblage of the Breccia (bed 2) contains no cold-climate species, and a temperate climate, perhaps towards the end of an interglacial, is indicated (Straw, 1983). The remainder of the faunal remains in the cave indicate open vegetation conditions typical of cool or cold steppe. The ages of these faunas and their associated archaeological assemblages are uncertain. Radiocarbon results reported by Campbell and Sampson (1971) from bone of bear and rhinoceros, probably from the Loamy Cave Earth (bed 4), found in association with earlier Upper Palaeolithic artefacts, gave ages of 28 160 ± 435 and 28 720 ± 450 BP. Bones of bear and giant deer from later Upper Palaeolithic contexts yielded dates of 14 275 ± 120 and 12 180 ± 100 BP. A radiocarbon determination (8070 ± 900 BP) on human bone collected by Pengelly (Hedges *et al.*, 1989) suggests that deposits above the Granular Stalagmite floor (bed 6) are of Mesolithic age. A fragment of human bone, probably of *Homo sapiens* Linné, collected during a 1920s' excavation and probably from the Loamy Cave Earth (bed 4), gave a date of 30 900 ± 900 BP, indicating a relatively early occupation of Britain by *H. sapiens*: the Mousterian artefact assemblage in the lower levels of the Loamy Cave Earth (bed 4) must be older than this, but specific dates are as yet unavailable.

The oldest deposits in the cave which contain faunal remains are difficult to date. The Breccia (bed 2) contains the bones of *Homotherium latidens* and perhaps *Ursus deningeri*: these species, and the accompanying voles, are regarded by most authorities to have become extinct in early Middle Pleistocene times (Stuart, 1982a). The occurrence of this cave bear, sabre-tooth and vole fauna, might indicate a broadly 'Cromerian' age for the Breccia (Straw, 1983). Certainly, the association of these bones with Acheulian artefacts is no longer problematical and it is now widely recognized that humans gained access to Britain relatively early in the Middle Pleistocene (Bishop, 1975; Wymer, 1985; Roberts, 1986; Shotton *et al.*, 1993). However, the possibility exists that the bones of the sabre-tooth and voles were reworked from an older deposit, and the precise age of the Breccia remains far from certain. Dates by the U-series and ESR methods (Proctor, 1994, 1996) suggest ages of 300 to 400 ka BP for the Breccia (bed 2) which would place it in Stage 9 or 11 of the oceanic Oxygen Isotope record. Such dates, particularly the latter, would confirm the early Middle Pleistocene age suggested by the mammalian evidence, and indicate that formation of the Crystalline Stalagmite (bed 3) and the erosion phase occupied a long period of Middle Pleistocene time.

The Crystalline Stalagmite is, in many places within the cave, severely broken so that sharp-edged blocks of it have become incorporated in the Loamy Cave Earth of bed 4 (Figure 5.2). Pengelly suggested that water pressure was responsible for the destruction of this crystalline layer, but Straw (1995, 1996) states that the uniform nature of the fracturing throughout the cave may indicate a more general cause – a seismic event? The youngest parts of the Crystalline Stalagmite have been dated by U-series to *c.* 100 ka BP (Proctor, 1994), thus suggesting that the inferred seismic disturbance occurred in the latter part of Oxygen Isotope Stage 5.

Conclusion

The deposits of Kent's Cavern provide an extensive record of sedimentation which spans the Middle and Upper Pleistocene. Evidence from the site supports both an early date for the occupation of the British Isles by humans and for the entrance of *Homo sapiens* into Britain. The richness of the faunal and archaeological remains makes Kent's Cavern one of Britain's most important Pleistocene sites. Its famous record of *Homotherium latidens* is unique in this part of the South-West: together with faunal remains at Westbury-sub-Mendip, it may provide evidence for temperate conditions in part of the Cromerian Stage. The remaining deposits at Kent's Cavern, together with the surviving museum specimens, provide great potential for elaborating conditions during a part of the Pleistocene which is otherwise only very poorly represented in South-West England.

TORNEWTON CAVE
A. P. Currant

Highlights

Tornewton Cave contains one of the most complete Upper Pleistocene sequences in Britain. Its deposits include the famous 'Glutton Stratum' and 'Hyaena Stratum', and recent studies confirm that the biostratigraphical succession spans at least two major interglacials – equivalent to Oxygen Isotope Stages 7 and 5. The cave provides the only record of the clawless otter in the British Pleistocene.

Introduction

The Torbryan Caves were discovered by James Lyon Widger (1823–1892) who referred to them as the 'Alexandra Caves'. The first excavations in the group of cave passages now known as Tornewton Cave were undertaken by him around 1877. His only personal reference to the caves was published posthumously (Widger, 1892). Widger's large collection of Pleistocene vertebrate remains and human artefacts from the caves was sold to the London dealer F.H. Butler and subsequently dispersed. Some 600 specimens labelled merely 'Torbryan Caves', many of which may have come from Tornewton Cave, are now in the Natural History Museum, London. Other material, similarly labelled, is widely scattered in public and private collections.

Re-examination of Widger's description of the caves and of a longer manuscript version of the same account (Torquay Natural History Society archives) shows him to have been a perceptive and skilful interpreter of the complex history of events represented by the deposits and structures which he examined. Regrettably he was not successful in attracting the interest of the scientific establishment of his day and much valuable information was irretrievably lost on his death. Early accounts of Widger's life and work were given by Lee (1880) and Lowe (1918), and these have since been supplemented by Walker and Sutcliffe (1968): some of his finds were also figured by Reynolds (1902, 1906, 1909, 1922).

Although further excavations were undertaken in the cave by A.H. Ogilvie, the results were not published and the main account of the site remains that of Sutcliffe and Zeuner (1962). These workers tentatively ascribed the principal deposits at Tornewton, on the basis of their contained faunal remains, to the 'Penultimate Glaciation' (Saalian), 'Last Interglacial' (Eemian) and 'Last Glaciation' (Weichselian). However, distinctive species groupings within the Eemian (Ipswichian) mammal remains at Tornewton, and at other British sites, led Sutcliffe (1975, 1976) to the far-reaching conclusion that the Ipswichian Stage comprised two separate temperate phases. Rodent remains from the site were described by Kowalski (1967) and Sutcliffe and Kowalski (1976). The site is also widely referred to in accounts of both national and regional Pleistocene history (e.g. Sutcliffe, 1969, 1995; Macfadyen, 1970; Kidson, 1977; Cullingford, 1982; Lowe and Walker, 1984). The importance of the Torbryan Cave sequences has been confirmed by recent detailed reinvestigation (Willemsen, 1992; Proctor, 1994; Barton, 1996; Berridge, 1996; Cartwright, 1996; Caseldine and Hatton, 1996; Currant, 1996; Debenham, 1996; Gleed-Owen, 1996; Irving, 1996; Price, 1996; Proctor and Smart, 1996; Seddon, 1996; Stewart, 1996; Roberts *et al.*, in prep.).

Description

The Torbryan Caves (Figure 5.1) occur in an outcrop of Devonian limestone on the south-west side of the Torbryan Valley, near Ipplepen, Devon. Tornewton Cave (SX 81726737) is an ancient feature bearing no clear relationship to present topography. The cave comprises two sub-vertical phreatic rifts with associated horizontal passages. The larger rift is called the Main Chamber and now has three separate connections to the outside: the Upper, Middle and Lower entrances. The Upper Entrance is a rock arch and was Widger's original access to the cave. The Middle Entrance connects with the Main Chamber via a narrow passage called the Middle Tunnel. The Lower Entrance is partly artificial and has been enlarged to give access into the Lower Tunnel, a structural extension of the Main Chamber in its lower part. The smaller rift is known as Vivian's Vault. It is a structural continuation of the Middle Tunnel, but the interconnecting passageway is narrow and totally blocked by stalagmite. A hole high in the wall towards the back of the Main Chamber now allows access to Vivian's Vault. Excavations outside the cave show that it once extended farther out into the Torbryan Valley.

An adaptation of Widger's description of the Tornewton Cave deposits (Widger, 1892; Widger, ms.) is repeated here because it provides the only firsthand account of several of the younger units and remains valuable for interpreting surviving deposits:

6. The 'Black Mould' – of unspecified thickness, containing flints, shells, pottery, pebbles, charcoal, a Roman coin and the remains of rodents. The pre-excavation floor of the cave was covered by slabs of angular stones.
5. 'Diluvium' (Widger believed in the Biblical deluge) – 5 feet (1.5 m) of an unspecified deposit containing a few worked flints, charcoal, and the remains of rodents and bats. This unit was capped by a white stalagmite floor about 1 foot (0.3 m) thick.
4. The 'Reindeer Stratum' – 6 feet (1.8 m) of red earth containing abundant reindeer antler, the ribs, vertebrae and limb bones of large animals and remains of a large species of bear.

The Reindeer Stratum is covered by a stalagmite floor 'a few inches thick'.

3. The 'Dark Earth' – 2 feet (0.6 m) thick and emitting an unpleasant smell when first dug and containing jaws and teeth of different animals, mainly hyaena. The Dark Earth contained a scatter of well-rolled quartz pebbles on its upper surface.
2. The 'Great Bone Bed' – 3 feet (0.9 m) thick and containing 'most of the British cave fauna'.
1. The 'Bear Deposit' – originally 7 feet (2.1 m) thick but mostly washed out. The remains of the 'smaller species' of bear were found here.

Widger's excavations at Tornewton Cave appear to have been extensive but cannot be delimited with any certainty due to later digging, mainly by Ogilvie and others in the late 1930s. Although these later excavations are unpublished and undocumented, extensive collections from them are held by the Torquay Natural History Society.

From 1944 until the early 1960s, the cave was excavated still further by A.J. Sutcliffe and colleagues. His findings elevated Tornewton Cave to international fame. He recovered a series of discrete mammal faunas in apparent stratigraphic superposition which were believed to span the period from the penultimate cold stage (in modern terms, Oxygen Isotope Stage 6), right through the last interglacial (Stage 5) and including much of the last cold stage (Stage 4 to Stage 2). The published stratigraphy and associated faunas (Sutcliffe and Zeuner, 1962) are summarized below with an updated taxonomy:

6. Hyaena Stratum – equated with Widger's 'Great Bone Bed'. Clearly the product of a prolonged phase of denning by the spotted hyaena *Crocuta crocuta* Erxleben. Much of this unit, which was also present throughout the Main Chamber and Lower Tunnel, consists of teeth, bones and bone debris, hyaena coprolites and fragmented coprolitic material. As in the underlying Bear Stratum, rock clasts were few in number. Some 1300 isolated hyaena teeth were recovered representing a minimum of 76 adult and 41 juvenile animals. (Widger claims to have recovered around 20 000 teeth from the same deposit.) Hyaenas of all ages were represented. The body-part representation from this unit is highly biased in favour of teeth and foot bones, other skeletal elements being quite rare. It would appear that the hyaenas had consumed all but the least digestible parts, even of their own kind. Species other than hyaena were quite rare given the abundance of bone within this unit, and in all cases they were represented by either teeth, foot bones or very heavily gnawed limb bone fragments. The following animals are listed: spotted hyaena, wolf *Canis lupus* Linné, fox *Vulpes vulpes* (Linné), lion *Panthera leo* (Linné), bear *Ursus* sp., narrow-nosed rhinoceros *Stephanorhinus hemitoechus* (Falconer), hippopotamus *Hippopotamus amphibius* Linné, fallow deer *Dama dama* (Linné), red deer *Cervus elaphus* Linné, a bovid (larger than that from the Glutton Stratum), hare *Lepus* sp., vole *Arvicola* sp., and undetermined species of bird. This fauna was taken to represent a considerable climatic amelioration and is assigned to the last interglacial (Stage 5/Ipswichian Stage).
5. Stalagmite Floor – forming a thin but fairly continuous sheet across the Main Chamber but represented by individual stalagmites in the Lower Tunnel.
4. Bear Stratum – described as immediately overlying the Glutton Stratum and extending the full length of the Main Chamber and Lower Tunnel. The authors maintain that there was no faunal distinction between the Bear Stratum and the underlying Glutton Stratum, but the nature of the deposit was apparently quite distinct. Although much of the remaining Bear Stratum was secondarily cemented, by infiltrating stalagmite, where it was not cemented the deposit was much less compacted than the Glutton Stratum and showed signs of faint internal stratification. There were occasional groups of related bones, and the very few contained rock clasts were of limestone rather than shattered stalagmite. No separate faunal list was given for this unit.
3. Glutton Stratum – a compacted, unstratified cave earth containing abundant teeth and bone fragments which represent a variety of vertebrate species, primarily bears. This deposit was believed to have accumulated by 'sludging' during periglacial conditions. The deposit was thickest (over 4.5 m) at the back of the cave, thinning out entirely at the mouth of the Lower Entrance. Other than abundant brown bear *Ursus arctos* Linné remains, those of wolf, fox and lion were recorded as common, while those of other species, such

as glutton *Gulo gulo* (Linné), reindeer *Rangifer tarandus* Linné, a small bovid and hare *Lepus* sp. were said to be rare. Other animals, often represented by single specimens, included horse *Equus ferus* Boddaert, a rhinoceros, badger *Meles meles* (Linné) and clawless otter *Cyrnaonyx antiqua* Blainville. The remains of rodents, bats, shrews, birds and fish were listed without further identification.

2. Stalagmite Formation – although listed as a separate bed by Sutcliffe and Zeuner (1962), this material comprises a large quantity of broken stalagmite which is found in the overlying bed. No such material is found in the underlying Laminated Clay and evidently this speleothem once capped the clay as part of a substantial and probably continuous floor/wall dripstone layer. Its break-up and redistribution into the Glutton Stratum were attributed to periglacial processes.
1. Laminated Clay – unfossiliferous waterlain clays and silts, excavated down to the water-table. The upper part of this unit was much disturbed and deeply incised by the overlying deposit (in effect bed 3; see note in bed 2).

Sutcliffe and Zeuner also described higher units within the cave, but these descriptions are based on interpretations of Widger's report and so do not represent new data. They do, however, describe a series of deposits outside the cave which adds to its palaeontological interest. At the bottom of their excavations, heavily disturbed laminated clays similar to those found inside the cave could be traced beyond the present extent of the cave system, but no direct equivalents of the Glutton Stratum, Bear Stratum, Hyaena Stratum or Widger's 'Dark Earth' were present. A series of very poorly fossiliferous 'head' or talus deposits, apparently containing rare finds of reindeer, had accumulated against the limestone cliff outside the cave, up to the level of the Middle Entrance. It would appear that the Middle Entrance and the Middle Tunnel provided the main access route to the Main Chamber, at least until the end of the last interglacial, at which time the inner end of the Middle Tunnel appears to have become blocked by rocks (Widger's observation).

Immediately outside the Middle Entrance, on top of the poorly fossiliferous head deposits, was a unit which Sutcliffe and Zeuner (1962) named the 'Elk Stratum'. This material, which was of very limited extent, nonetheless produced quite a rich faunal assemblage, including spotted hyaena, woolly rhinoceros *Coelodonta antiquitatis* (Blumenbach), horse and reindeer. Overlying deposits, believed by the excavators to represent an external equivalent of Widger's 'Reindeer Stratum', contained less abundant remains of the same faunal assemblage, but with the interesting inclusion of a human lower incisor and several flint implements. This faunal grouping was attributed to an interstadial phase within the Devensian Stage. The 'Elk' from which this deposit took its name was later re-identified as a red deer (A. Lister, pers. comm.).

Subsequently, Sutcliffe extended his excavations into Vivian's Vault. Here, he removed a large quantity of spoil dumped by earlier excavators and discovered a previously unrecorded deposit containing abundant microvertebrate remains, including those of a white-toothed shrew *Crocidura* sp. (Rzebik, 1968), a large number of bird bones and the teeth and bones of the clawless otter *C. antiqua*. These discoveries are mentioned by Sutcliffe and Kowalski (1976) under the designation of finds from the Otter Stratum. The rodent remains from this deposit were listed by Sutcliffe and Kowalski (1976) as follows:

Cricetus cricetus Linné	
European hamster	2 specimens
Lagurus lagurus (Pallas)	
steppe lemming	1 specimen
Dicrostonyx torquatus (Pallas)	
collared lemming	12 specimens
Lemmus lemmus (Linné)	
Norway lemming	1 specimen
Microtus nivalis (Martins)	
snow vole	4 specimens
Microtus oeconomus (Pallas)	
northern vole	82 specimens
Apodemus sylvaticus (Linné)	
wood mouse	2 specimens
Clethrionomys glareolus (Schreber)	
bank vole	19 specimens
Microtus agrestis (Linné)	
short-tailed vole	5 specimens
Arvicola sp.	
water vole	8 specimens

The authors noted that this stratum contained a mixture of two possibly discrete faunal assemblages. Remains from a warm period predominated, and contained clasts of stalagmite yielded only temperate forms such as *M. agrestis*, *M. oeconomus*, *Arvicola* sp., *C. glareolus* and *A. sylvaticus*. This temperate fauna was attributed to the last interglacial (Ipswichian Stage), while species such as *L. lagurus*, *C. cricetus* and *M. nivalis* were taken to indicate cold conditions during the penultimate cold stage (Oxygen Isotope Stage 6). The colder elements found in the deposits of the Otter Stratum were correlated with similar finds described from the Glutton Stratum in the same publication. Such an interpretation appeared to be secure, given the fact that the Glutton Stratum was stratified beneath the Hyaena Stratum and intervening Bear Stratum, and the Hyaena Stratum contained a large-mammal fauna characteristic of the Ipswichian.

Interpretation

Recent reappraisal of the Tornewton Cave collections now housed in the Natural History Museum, London, and selective excavation and sampling within the cave as part of the British Museum's Torbryan Caves Research Project, have together led to a partial reinterpretation of the Tornewton Cave sequence (Currant, 1996; Roberts *et al.*, in prep.).

Existing collections of material, recorded as having come from the Glutton Stratum, contain a much wider range of species than originally listed by Sutcliffe and Zeuner (1962). Newly identified species include: hedgehog *Erinaceus europaeus* Linné, marten *Martes* sp., narrow-nosed rhinoceros, hippopotamus, fallow deer, red deer, roe deer *Capreolus capreolus* (Linné) and wild boar *Sus scrofa* Linné. Together, these animals add a strongly 'temperate' component to what is supposed to be a cold, Oxygen Isotope Stage 6, assemblage. Samples taken from the Glutton Stratum during the British Museum excavations by Lorraine Higbee were examined for signs of internal stratification. She confirmed the complete admixture of temperate and boreal indicators noted above, and recovered the conjoining halves of a dentary of a glutton from two adjacent samples. This find was notable for its relative completeness and excellent state of preservation. Following a lead suggested by Widger's original description of the cave, in which he indicates the existence of some kind of partially blocked tunnel running down the back of the Main Chamber and through his 'Bear Deposit', this specimen yielded an Accelerator Mass Spectrometry (AMS) radiocarbon age estimate of 22 160 ± 460 BP (OxA-4587).

This dating has helped considerably in interpreting the controversial Glutton Stratum. The deposit would appear to have been emplaced, possibly under periglacial conditions, close to the Devensian stadial maximum (Oxygen Isotope Stage 2). It contains material from older units within the cave, including material which must have come from Widger's 'Reindeer Stratum' and from his 'Dark Earth', the Hyaena Stratum and the Bear Stratum. It may also include material from even older deposits which once adhered to the back wall of the cave. Sutcliffe and Zeuner (1962) described a 'cave within a cave' feature in the lower part of the Main Chamber, caused by the collapse of partly consolidated sediments which belonged to both the Bear Stratum and Hyaena Stratum. It seems likely that this collapse took place at the time of, or shortly after, the emplacement of the Glutton Stratum beneath them.

This might explain the curious absence of Middle Devensian deposits inside the cave. It seems likely that most of the cave system was completely filled during the earlier part of the Devensian (Oxygen Isotope Stage 4) and remained so throughout the Middle Devensian (Stage 3). During this phase, the only access appears to have been to the Middle Tunnel, where the Elk Stratum and associated deposits contain the only characteristically Middle Devensian fauna. It seems likely that the Elk Stratum deposits are themselves part of a small debris flow issuing from the mouth of the Middle Tunnel. Only after material filling the upper part of the cave had become mobilized and flowed down the back of the Main Chamber, was the main cavern space partially reopened. It is possible that the dated glutton jaw belonged to an animal that was using the cave while the debris flow process was still active.

Excavations in the entrance to Vivian's Vault in 1991 and 1992 located a small remnant of *in situ* Hyaena Stratum overlying quite a large fragment of *in situ* Bear Stratum against the wall of the vault, confirming Widger's description of the sequence here. Immediately beneath the Bear Stratum, where the walls of the vault converge, a thin unit of barren clay overlies a partly broken stalagmite floor. This stalagmite contained pockets of sediment rich in *Crocidura* remains and had bones of clawless otter adhering to some of its broken surfaces. This stratigraphic relationship, between the Bear Stratum and the deposits of the Otter Stratum, would seem to confirm that the latter represents a pre-Stage 5 temperate phase. *Crocidura* has not been found in any Stage 5 contexts in Britain, but appears to be a characteristic element of what are believed to be Stage 7 faunas from other British sites such as Aveley and Orsett Road, Essex and Itteringham, Norfolk (Currant, 1989). Detailed examination of blocks of partly cemented sediment suggests a very complex history of deposition, but most of the deposits excavated in Vivian's Vault appear to represent material which originally accumulated under temperate conditions. At present there is no reason to suppose that the deposits belong to more than one temperate stage. The vault is less than 0.3 m wide in places, so digging conditions are extremely difficult, but it is believed that the exact area where Sutcliffe recovered the cold elements of his Otter Stratum rodent fauna has been located. Immediately beneath the entrance to Vivian's Vault from the Main Chamber there is a 'pipe' of sediment running down into the disturbed sediments of the Otter Stratum, apparently associated with the broken edge of the stalagmite floor mentioned above. A palate and dentary of a European hamster has been recovered from a sample of this deposit, which is tentatively interpreted as a smaller-scale debris flow, similar in character to the Glutton Stratum in the Main Chamber, though possibly much older. Sadly, the deposits immediately overlying this feature had already been excavated, so it was not possible to establish whether this feature was sealed by the Bear Stratum and Hyaena Stratum, or whether it cut through them.

An interesting microvertebrate assemblage has recently been recovered from a complex sequence of stalagmite deposits which block the passage between the inner end of the Middle Tunnel and Vivian's Vault beyond. Sandy partings in the stalagmite have yielded *Lemmus*, numerous teeth of *M. oeconomus* and as yet unidentified bird remains. This cold-stage assemblage superficially resembles some pre-Stage 5 faunas like that from Crayford, Kent, but its age remains uncertain.

In 1992 a large stalagmite mass blocking the back of the Main Chamber, just by the entrance to Vivian's Vault, was drilled through and access was gained to a small cavern space beyond. This has been named the Main Chamber Extension. The extension contained an undisturbed sequence equivalent to at least the upper part of the Bear Stratum, the Hyaena Stratum and Widger's 'Dark Earth'. These deposits were sampled for microvertebrate fossils and surprisingly the Hyaena Stratum yielded quite profuse remains of northern vole. This species, which is usually found in wet grasslands, tends to be absent from deposits representing the warmest part of the Ipswichian Stage (Stage 5e), yet there is good reason to suppose that this is the only period in which the hippopotamus was present in Britain during the later part of the Pleistocene. Stalagmite containing hippopotamus remains from Victoria Cave in North Yorkshire has been dated to around 125 000 BP (Gascoyne *et al.*, 1981). At Bacon Hole, West Glamorgan, a series of mammal faunas recovered from Stage 5 sediments shows that *M. oeconomus* is not present in local faunas during the earlier part of the stage, but is quite common during subsequent sub-stages of the interglacial (Currant *in* Sutcliffe *et al.*, 1987).

These findings have major repercussions for re-evaluating the Tornewton Bear Stratum. Sutcliffe and Kowalski (1976) described a small assemblage of rodent remains found close to the entrance to the Lower Tunnel which they interpreted as being contemporary with the Bear Stratum. The assemblage includes *D. torquatus*, *L. lemmus*, *C. glareolus*, *Arvicola* sp., *M. agrestis*, *M. nivalis*, *M. oeconomus* and *L. lagurus*, and was originally correlated with the Glutton Stratum as the equivalent of a Stage 6 assemblage. However, this collection of material appears to be far more closely connected with deposits immediately outside the originally narrow Lower Tunnel Entrance than it does with anything inside, and examination of Sutcliffe and Zeuner's own section through the cave deposits (Sutcliffe and Zeuner, 1962; plate 28) shows this to be the case.

It should be noted that the snow vole *M. nivalis* is not now believed to have been present in Britain during the Quaternary, and that material ascribed to this species actually represents a minor dental variant of *M. oeconomus* (A.J. Stuart, pers. comm.). Moreover, the biostratigraphic significance that has previously been attached to the occurrence of this form (Sutcliffe and Kowalski, 1976) is equally unfounded, similar morphologies having been found in faunas of widely different age. It is possible that the records of such species as *L. lagurus* at Tornewton Cave represent new elements of a poorly known Early Devensian (Oxygen Isotope Stage 4) fauna rather than being part of an even more poorly known Stage 6 fauna. Even such well-known temperate species as *M. agrestis* and *C. glareolus* may be making spurious appearances in faunal lists, particularly when unequivocally associated with more boreal species. The teeth of the narrow-skulled vole, a boreal species, often closely resemble those of *M. agrestis*, and the more boreal species of *Clethrionomys*, such as *C. rutilus* and *C. rufocanus*, may well have gone unnoticed: the identity of all of this material has to be re-checked.

Returning to the Bear Stratum, examination of the collections from Sutcliffe's excavations arouses the suspicion that it was not always certain which deposit was being excavated. The only species which appears to have been common in the Bear Stratum was brown bear. In fact, there is nothing else in the collection which is definitely said to have come from the Bear Stratum, which is particularly odd given the observation that, on faunal grounds, the Bear Stratum could not be differentiated from the Glutton Stratum (Sutcliffe and Zeuner 1962; p. 131). There is a varied group of material marked up as 'H.S./B.S. undifferentiated' (including at least one specimen of *Hippopotamus*) and an even larger group marked up as 'B.S./S.B. undifferentiated' (S.B. = sub-Bear, the original name for the Glutton Stratum). The only firm information available on the fauna from the Bear Stratum comes from a series of samples collected inside the entrance to Vivian's Vault in 1991 by Cornish who was able to demonstrate that the contained microvertebrate fauna was consistently interglacial in character.

The Bear Stratum, therefore, accumulated under warm temperate conditions, most likely the early part of the last interglacial (Stage 5e). This fits in well with the abundance of *M. oeconomus* in the overlying Hyaena Stratum which can probably be placed in Stage 5c, and with the survival of interglacial fauna into the overlying 'Dark Earth' which probably represents Stage 5a, but does not square particularly well with the reported occurrence of *Hippopotamus* in the Hyaena Stratum, especially as the two deposits are separated by a minor phase of stalagmite formation, suggesting the passage of a significant period of time between their deposition.

Hippopotamus fossils are not common at Tornewton Cave, and nearly all of the individual specimens present in the collections at the NHM have something odd about them. Several are from poorly stratified contexts, one in the Glutton Stratum has been derived, and most of the remainder have clear signs that their original field data have been erased or altered. The largest piece, a fragment of canine tooth with a dark, heavy staining quite unlike all other Hyaena Stratum specimens, was found on a spoil heap (A.J. Sutcliffe, pers. comm.) even though it is marked '(H.S.)'. Sadly, it would appear that little faith can be placed on the provenance of a number of biostratigraphically significant specimens which have been attributed to the Hyaena Stratum. One should not be too critical of such discoveries. Interpretation of cave deposits is often difficult, particularly when dealing with huge amounts of compacted spoil from earlier excavations and isolated blocks of *in situ* sediments, themselves partly disturbed by collapse. Given the then-prevailing belief that the Bear Stratum represented a non-temperate environment, one can understand the collector's doubts about the provenance of earlier finds which originally may have been attributed to this unit but which were themselves temperate indicators.

Fortunately the new finds from the Main Chamber Extension are from unambiguous contexts. It is unlikely that some of the rarer species will be represented in the samples taken from the 1992 excavations, but there should be enough environmental data to resolve the exact placement of the various Stage 5 deposits. Particular hope is pinned on obtaining Uranium-series dates from a clean, crystalline stalagmite boss which was found growing on the Bear Stratum and sticking up through the Hyaena Stratum and the overlying 'Dark Earth', with 'skirts' marking the tops of each of these units.

The lateral equivalent of Widger's 'Reindeer Stratum' has been found in a previously unexplored horizontal 'tube' (Price's Passage) leading outwards from the Main Chamber just below the Upper Entrance. It may have had an entrance just above the Middle Entrance in what is now a mass of shattered rock and tree roots, but it would be unsafe to explore this further from the outside. Price's Passage is partly choked with soft, dark red loam which contains angular limestone fragments and a fauna with reindeer, bison and wolf. It appears to have been a wolf den for a significant time during the earlier part of the Devensian (Stage 4).

Conclusion

An interglacial vertebrate fauna with *C. antiqua* and abundant *Crocidura* has been recovered from the Otter Stratum of Vivian's Vault and is correlated with Oxygen Isotope Stage 7. A minor debris flow penetrating the Otter Stratum deposits contains a cold fauna with *Lagurus* and *Cricetus*. Its age is uncertain, but it could belong to Stage 6. The Bear Stratum, representing a major phase of denning by the brown bear, the Hyaena Stratum, representing a major phase of occupation by the spotted hyaena, and the 'Dark Earth', representing a less intense phase of hyaena usage, each contains interglacial faunas which appear to represent the warmer episodes of Stage 5. Overlying deposits, now found only as isolated remnants, contain what appears to be a Stage 4 fauna dominated by *Rangifer* and

Bison. A coherent Stage 3 assemblage, with *Coelodonta*, *Equus* and *Crocuta*, is represented outside the cave by material at the mouth of the Middle Tunnel. At some time during Stage 2, a huge mass of cave deposit formed a debris flow which moved down the back of the cave and beneath the remaining stratified sequence. This constitutes the deposit known as the Glutton Stratum. It has been seen to fill deep, steep-sided cavities in the underlying waterlain sediments and contains a highly mixed and derived fauna. Later deposits have been entirely removed by previous excavators.

CHUDLEIGH CAVES
S. Campbell and S.N. Collcutt

Highlights

Deposits containing rich archaeological and palaeontological remains make Chudleigh Caves important for reconstructing late Middle and Upper Pleistocene environmental conditions in South-West England.

Introduction

Chudleigh Caves, and Pixie's Hole in particular, have long been important for Pleistocene studies. The caves were extensively excavated in the nineteenth century by Buckland, Ackland, Trevelyan, Northmore and MacEnery among others. Pengelly (1873b) provided a useful account of these early explorations and gave details of the artefacts and bones recovered as the cave deposits were quickly sifted and removed. More recent accounts of the caves and their deposits were provided by Beynon (1931), Shaw (1949a, 1949b) and Simons (1963), and the site has been placed in a wider context by Cullingford (1953, 1962), Sutcliffe (1969, 1974, 1977), Macfadyen (1970), Campbell (1977) and Selwood *et al*. (1984). Detailed accounts have been provided of the cave sediments and fauna (Collcutt, 1984, 1986) and the Palaeolithic and Mesolithic artefacts (Rosenfeld, 1969; Collcutt, 1984). Holman (1988) described a herpetofauna from Cow Cave.

Description

Some 20 caves, mostly small, are located in the Chercombe Bridge Limestone around Chudleigh in Devon (Selwood *et al*., 1984; Figure 5.1). The best known are Pixie's Hole, Chudleigh Cavern and Cow Cave which are located in or around Chudleigh Rocks (SX 865787): several fissures in the immediate vicinity also contain important deposits. Chudleigh Rocks is part of a restricted outcrop of the Devonian limestone (Selwood *et al*., 1984) which has been bisected at Chudleigh by the Kate Brook; the resulting gorge is known as the Glen. The Kate Brook rises on Great Haldon some 7 km to the north-east, and joins the Teign *c*. 0.5 km downstream of Chudleigh Rocks. The geology around the Rocks is complex, and the lithologies traversed by the Kate Brook in its upstream catchment are diverse. The latter, which include Carboniferous shales and sandstones, Devonian limestone, Lower Cretaceous pebble and shell beds and, notably, the Upper Carboniferous/Lower Permian Teignmouth Breccia, are important constituents of the cave sediments (Collcutt, 1984). The GCR site consists of Chudleigh Rocks themselves (containing the caves of Pixie's Hole and Cow Cave), Chudleigh Cavern a short distance to the north and part of the gorge (containing Tramp's Shelter). The site includes slope and terrace deposits which may eventually be linked with the history of the caves themselves.

Cow Cave

Cow Cave (SX 86467867) is located on the south side of the Rock. Its entrance, some 6 m wide by 4.5 m, high leads into a spacious cavern about 18 m long (Shaw, 1949b). This cave receives no mention in Pengelly's (1873b) account of the Chudleigh Caves, and it is not clear if any of the early cave explorers, such as MacEnery or Buckland, visited it. The first account of the cave, its layout and deposits, appears to be that by Beynon (1931) who summarized the results of excavations by the Torquay Natural History Society between 1927 and 1931. Unfortunately, none of the mammal remains, including bear, wolf, fox, hyaena, deer, wild cat, Irish deer and ox, nor the eight flint implements, comes from a known stratigraphic context. Beynon (1931) alludes to a stratigraphic sequence of surface 'limestone' soil, overlying stalagmite and a series of cemented and uncemented breccias, but even these details are unclear. Great numbers of well-rounded pebbles were also described from the cave, and were believed to have been washed in by great floods during a 'long pluvial period' (Beynon, 1931). Collcutt (1984) comments that the cave deposits described by Beynon appear to bear similarities with the Siliceous Group described from Pixie's Hole (Collcutt, 1984; see below). The Torquay Natural History Society excavations continued at Cow Cave until at least 1935 (Alexander, 1933, 1934, 1935), although no further detailed publication followed (Collcutt, 1984). Human remains, and those of rhinoceros and beaver were added to the faunal list and one flint of Aurignacian type was recovered (Alexander, 1935).

The most detailed accounts of this cave, however, are those by Simons (1963) and Rosenfeld (1969). Simons recorded the following stratigraphy:

6. Stalagmite floor
5. Frog stratum
4. Stalagmite floor
3. Reindeer stratum
2. Broken stalagmite floor
1. Stream deposit

Based, unsatisfactorily, on the state of their preservation, Simons assigned bones to the various stratigraphic levels. The earliest deposit (stream deposit; bed 1) was deemed to have yielded bear, lion, hyaena, red deer and a rodent. The reindeer stratum (bed 3) is considered to have contained bear, hyaena, bison, reindeer, hare, red deer, roe deer and water vole (Simons, 1963). From the most recent clastic sediment, presumably the Frog stratum (bed 5), are believed to have come the remains of hare, rabbit, dog, hedgehog, sheep, pig, horse and humans among others (Simons, 1963). The occurrence of *M. nivalis* among the various rodent remains excavated from the cave by Simons, led Sutcliffe and Kowalski (1976) to speculate that a pre-Ipswichian deposit may be present at the site. However, the tooth in question is non-diagnostic of the species, and *M. oeconomus* (common in the Late Devensian) is a likely alternative.

Rosenfeld (1969) recorded that six flakes of Middle Palaeolithic age had been recovered from the cave. One flake, from Simons' (1963) investigations, had purportedly come from bed 1. Since the Reindeer stratum (bed 3) lying above this deposit and above a layer of fractured stalagmite (bed 2) was believed to be of 'last glacial' (Devensian) age, it has been speculated that this artefact may have been derived from an interglacial deposit of pre-Devensian (possibly even pre-Ipswichian?) age (Rosenfeld, 1969; Sutcliffe, 1969). The flakes were described by Rosenfeld as coming from prepared cores, some having faceted platforms, but none being of distinctive types. Campbell (1977), on the other hand, regarded the artefacts as of Earlier Upper Palaeolithic age. In addition to the Middle Palaeolithic (Rosenfeld, 1969), Aurignacian (Alexander, 1935) and 'Azilian' (Beynon, 1931) age interpretations, it is even unclear whether the authors are referring to the same or to different objects (Collcutt, 1984). However, the 'Azilian' piece referred to by Beynon is extant (a curved-back point), and almost identical to those found by Collcutt in Pixie's Hole: these tools are indicative of a date late in the Devensian Stage.

Collcutt (1984) has argued that Cow Cave and Pixie's Hole were probably once connected; the westernmost extension of the latter consists of a sediment-choked passage at the same level, and only *c.* 12 m from the easternmost extension of Cow Cave, which is similarly choked with deposits (Collcutt, 1984).

Tramp's Shelter

Tramp's Shelter lies on the south-east side of the Kate Brook, almost above the waterfall (Collcutt, 1984). It occurs in a steep bluff of limestone and has a south-westerly-facing entrance at *c.* 51 m OD. This deep shelter penetrates about 10 m inwards from a 6 m-wide entrance. The history of excavation at this cave is far from clear; certainly much material has been removed from the cave and at its entrance (Collcutt, 1984). Rosenfeld (1969) refers to work by Miss M. Collins and a cave earth which had yielded bones of *Bos*, *Equus* and *Cervus elaphus* Linné. The same deposit also apparently contained a 'backed blade industry with obliquely blunted blades' (Rosenfeld, 1969). Campbell (1977) refers to excavations by Smith, apparently in 1968, and refers to 10 artefacts, possibly attributable to the late Upper Palaeolithic.

Collcutt (1984) also briefly examined Tramp's Shelter, recording at least 2 m of homogeneous deposits (limestone scree and blocks set in a dense matrix of red gritty clay), and recovered several flint artefacts (certainly of Later Upper Palaeolithic age).

Chudleigh Fissure

The location of this feature is not clear. It is recorded as a palaeontological site which has yielded the remains of small mammals (Sutcliffe and Kowalski, 1976) and birds (Bramwell, 1960) indicative of cold conditions probably during the Devensian Stage. An early reference to the site by Hinton (1926), cites Kennard as the original excavator (Collcutt, 1984).

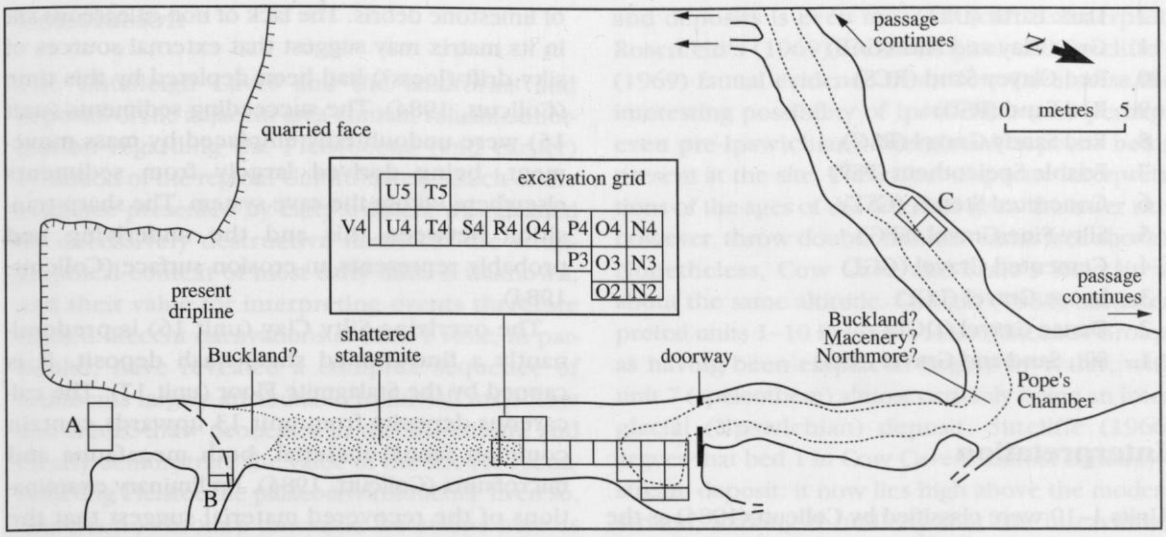

Figure 5.3 Plan of Pixie's Hole, after Collcutt (1984).

Pixie's Hole

This cave is located on the south side of Chudleigh Rocks (at SX 86547867), and passes through the remaining limestone which has been left by quarrying on both its northern and southern sides (Collcutt, 1984; Figure 5.3). It is undoubtedly the most important of the Chudleigh Caves. It is a relatively small but complex cave system, the full extent and layout of which are not fully known. Shaw (1949a, 1949b) provided descriptive details of the cave and passage morphology. He recorded a vertical network with 265 m of passages and with four openings; Selwood *et al.* (1984), however, refer to only three openings. The areas relevant to the recent investigations are clearly marked on a plan given by Collcutt (1984) (Figure 5.3). The most important area of the cave currently known is the relatively simple eastern section, although farther west the cave develops on at least four different levels, and choked passages lead off perhaps linking up with other named entrances elsewhere in the Chudleigh Rocks (Collcutt, 1984). Much of the long eastern passage, which runs northwards into the Pope's Chamber, is developed in a near-vertical fault (Collcutt, 1984). The cave formerly contained fine karst features including stalactite curtains (Shaw, 1949b), but these have been seriously degraded by visitors. (The entrances are now gated.)

The earliest known reference to the cave is that in Ridson's *Survey of Devon* (carried out between 1605 and 1630; Ridson, 1911), although it was probably first mentioned in a scientific context by Paddon (1797) who estimated the extent of the cave. Buckland is the first recorded excavator: according to Pengelly (1873b), he probably dug there in 1824–1825, finding flints, pottery, domestic animal bones and charcoal. The results of these excavations were never published by Buckland, although brief mention is given to the site in his 1824 *Reliquae Diluvianae*. Again, according to Pengelly (1873b), Buckland visited the cave in 1825 with Sir Thomas Acland, finding the remains of 'antediluvian animals' such as hyaena, deer and bear. Excavations were continued between about 1829 and 1841 by MacEnery, but little extra faunal material was recovered (Pengelly, 1873b). From the notes and letters left by these early workers, including Northmore, Pengelly (1873b) summarised that the remains of rhinoceros, ox, hyaena, deer, bear, elephant and hippopotamus had been recovered from the caves at Chudleigh.

Collcutt (1984) excavated at four locations within the eastern part of Pixie's Hole, proving depths of cave sediment in excess of 5 m. The stratigraphy is extremely complex and variable across the cave: Collcutt provides a comprehensive lithostratigraphic classification of the deposits. These are, from top to bottom, as follows:

17. Stalagmitic floor (STF)
16. Silty Clay (SCL)
15. Diamicton (DIA)
14. Stony Cave Earth (SCE)
13. Stony Silt (SST), Dark Silt (DST) and Light Silt (LST)

12. Dark Earth (DET)
11. Grey Clay and Silts (GCS)
10. Red Clayey Sand (RCS)
9. Red Sand (RSD)
8. Red Sandy Gravel (RSG)
7. Friable Speleothem (FSP)
6. Concreted Stones (CST)
5. Silty Fine Gravel (SFG)
4. Cemented Gravel (CGL)
3. Loose Gravel (LGL)
2. Dense Gravel (DGL)
1. Silt, Sand and Gravel (SSG)

Interpretation

Units 1–10 were classified by Collcutt (1984) as the Siliceous Group. Bedding structures in these sediments suggest that they were emplaced largely by water, although at various levels there are also signs that deposition occurred by mass movement (debris flow). The overall impression of the sediments which comprise this group, however, is that they are similar to normal subaerial alluvial fan deposits (Collcutt, 1984). Within this part of the sequence, the carbonate-rich units (6 and 7) are clearly identifiable as a cave breccia capped by a stalagmitic floor (Collcutt, 1984). Most of the bones recovered from unit 6 are those of bear. Unit 7 is almost certainly an interglacial deposit. Collcutt favours an Ipswichian age, although the material (recrystallized) is undateable.

The succeeding Grey Clay and Silts (unit 11) appear to have entered the cave via a fissure in its roof: the overlying Dark Earth (unit 12) is composed of similar material, and its convoluted lower boundary may suggest subsequent mass movement (Collcutt, 1984). The overlying silty units (unit 13) appear to have been emplaced by wash processes; fine lag gravels, 'puddle' deposits and micro-deltas also occur in these units, providing evidence for a complexity of depositional environments within the cave system at this time. Taking the sequence as a whole, there appears to be evidence for a reduction in energy levels up through the deposits. Some of the sediments within unit 13 may have been derived from loessic material outside the cave: remains of woolly rhinoceros *C. antiquitatis* in this unit have been seen as compatible with a 'Main Devensian' age (Collcutt, 1984). These secondary loess deposits are closely comparable with deposits in the platform sequence at Tornewton Cave and may be of a similar age.

Unit 14 is a typical cave earth composed largely of limestone debris. The lack of non-calcareous silt in its matrix may suggest that external sources of silty drift (loess?) had been depleted by this time (Collcutt, 1984). The succeeding sediments (unit 15) were undoubtedly emplaced by mass movement, being derived largely from sediments elsewhere within the cave system. The sharp transition between this and the underlying bed probably represents an erosion surface (Collcutt, 1984).

The overlying Silty Clay (unit 16) is predominantly a fine-grained sheet-wash deposit. It is capped by the Stalagmite Floor (unit 17). The calcareous deposits from unit 13 upwards contain common faunal material, both megafauna and microfauna (Collcutt, 1984). Preliminary examinations of the recovered material suggest that the bones of bear, hyaena, wolf, fox, reindeer, red deer, *Bos* sp., woolly rhinoceros and horse are present (Collcutt, 1984). Initial interpretations of the fauna indicate that it forms a 'cold' assemblage, perhaps of later Devensian age (Collcutt, 1984). The presence of *Bos* at this high stratigraphic level might suggest an interstadial, possibly the Windermere Interstadial (see below).

Collcutt's (1984) excavations also yielded archaeological material, some 400 artefacts largely of flint, all referable to the Later Upper Palaeolithic (*sensu* Campbell, 1977). Dense spreads of redeposited charcoal occur between units 15 and 16, and some flints also show signs of having been burned, indicating that there is evidence for at least one hearth to have been present within the cave (Collcutt, 1984). Collcutt plotted the positions of the recovered artefacts and concluded that the principal source was the Stony Cave Earth (unit 14), which may have carried a 'living floor'. The distribution of the finds suggests that in places this floor may remain undisturbed. Nonetheless, elsewhere, the artefacts have been reworked and incorporated into the overlying mass flow deposits (Collcutt, 1984). There appears to be no typological difference between the artefacts found in these units. Although the artefacts and hearth feature of unit 14 may amount to an 'archaeological occupation', there is no direct evidence to relate the artefacts to the faunal remains (Collcutt, 1984). Much faunal material does occur at this level in the sequence, and while there are many herbivore bones which it is tempting to relate to the archaeological material (butchered?), the occurrence of carnivore bones suggests that animals such as wolf, may have been responsible for the accumulations (Collcutt, 1984).

Conclusion

The Chudleigh Caves and the landforms and deposits of the adjacent area contain valuable information regarding the Pleistocene (and earlier) evolution of the region. Unfortunately, much of the evidence presented by early workers was gleaned by excessively destructive methods: the stratigraphical context of most early finds is unknown, and their value for interpreting events therefore limited. Recent excavations at Pixie's Hole, in particular, have revealed a complex sequence of sediments largely attributable to fluvial, mass flow and freeze-thaw processes in the Devensian, and clearly demonstrate the value of the site for reconstructing Pleistocene palaeoenvironments. Even so, there is no absolute timescale for events here as yet, and much of the archaeological and faunal material remains to be published in detail.

Firm evidence for a Later Upper Palaeolithic occupation of Pixie's Hole can, however, be demonstrated. Not far from the main entrance occurs a 'living floor' consisting of a rudimentary hearth (charcoal, burnt limestone and flint, underlain by baked fine sediment). Elsewhere, farther into the cave system, the tools from this occupation have been dispersed by debris flows.

Pixie's Hole, in particular, provides intriguing evidence for the activities of Upper Palaeolithic humans in Devon. It is clear that flint was knapped at the site; debitage, retouched tools and cores have been recovered. It is likely that the occupation occurred in respect both to the shelter afforded by the cave and with regard to local supplies of flint. Although the local flint gravels are not totally unsuitable for tool manufacture, the presence of good quality flint farther afield in the Kate Brook catchment may well have been a critical factor in the selection and occupation of Pixie's Hole (Collcutt, 1984, 1986).

Dating this occupation, beyond a general ascription based on the faunal evidence, to the Late Devensian is problematical. None of the bone or antler recovered from Pixie's Hole carries unequivocal traces of human modification. Indeed, there is ample evidence for the presence at Chudleigh of denning carnivores. Therefore it is not possible to link the archaeological and faunal evidence directly in time. The industry on its own, however, is fully compatible with a Later Upper Palaeolithic date; a Federmesser industry slightly younger than the classic Creswellian seems likely (cf. the 'Final Palaeolithic' of Barton (1996)).

The evidence from the other Chudleigh caves and deposits is even more difficult to interpret. Rosenfeld's (1969) archaeological and Sutcliffe's (1969) faunal evidence from Cow Cave, raise the interesting possibility of Ipswichian (and perhaps even pre-Ipswichian) interglacial deposits being present at the site. The rather disparate interpretations of the ages of the artefacts from the latter site, however, throw doubt on to this claim (see above). Nonetheless, Cow Cave and Pixie's Hole lie at about the same altitude. Collcutt (1984) has interpreted units 1–10 in Pixie's Hole (Siliceous Group) as having been emplaced largely by water, with unit 7 (speleothem) almost certainly being an interglacial (?Ipswichian) deposit. Sutcliffe (1966) argues that bed 1 in Cow Cave is almost certainly a stream deposit: it now lies high above the modern stream, making it unlikely that the intervening downcutting could have taken place within the timespan of the Devensian alone.

The full potential of the Chudleigh Caves for elaborating regional Pleistocene conditions has not yet been realized: their remaining artefact- and bone-bearing beds (Pixie's Hole has the most extensive Later Upper Palaeolithic deposits known to survive at any British cave) will undoubtedly contribute significantly to the growing knowledge of Pleistocene humans and their environment in Devon.

JOINT MITNOR CAVE

S. Campbell and A.J. Stuart

Highlights

Joint Mitnor Cave has yielded one of the richest fossil assemblages of Ipswichian age yet known in Britain. Much of the fossiliferous deposit is preserved *in situ*.

Introduction

Joint Mitnor Cave is one of several caves opening into the disused Higher Kiln Quarry, at Buckfastleigh in Devon. Although long known as a cave, it was discovered to contain bones in 1939, and was named after W. Joint, W. Mitchell and F.R. Northey. Three main deposits can be distinguished in the cave: 1. a basal, unfossiliferous waterlain deposit; 2. an overlying, highly fossiliferous cave earth, which has yielded a profusion of mammal bones and teeth characteristic of the Ipswichian Stage; and 3. a capping stalagmitic floor. The deposits were excavated between 1939 and 1941 by A.H. Ogilvie and other members of the Torquay Natural History Society (Anon., 1948), and most of the finds now lie in the Torquay Natural History Society Museum and in the British Museum (Natural History), London. A permanent demonstration section of the deposits, with bones *in situ*, has been preserved at the site. The fauna was re-examined in detail by Sutcliffe (1960) and Sutcliffe and Kowalski (1976), and the site has been referred to widely in regional and national syntheses of Pleistocene history (e.g. Sutcliffe, 1969, 1974, 1977; Macfadyen, 1970; Stephens, 1973; Cullingford, 1982; Stuart, 1982a, 1982b, 1983, 1995).

Description

Joint Mitnor Cave (SX 744665) is part of a large cave system which has been intersected by two large quarries, Baker's Pit and Higher Kiln Quarry, excavated close to Buckfastleigh Church. The system includes Baker's Pit Cave (opening in Baker's Pit), and Reed's Cave, Disappointment Cave, Rift Cave, Spider's Hole and Joint Mitnor Cave – the latter all opening into Higher Kiln Quarry. The system contains over 2100 m of passages lying between *c.* 61–82 m OD (Sutcliffe, 1960, 1977; Macfadyen, 1970). The caves lie some 250 m to the west of the River Dart which flows in a generally south-east direction at a level of *c.* 40 m OD. The river is bordered by a low terrace, and has a well-developed terrace on the east bank at *c.* 60 m OD and another on the west bank at *c.* 90 m OD (Sutcliffe, 1977).

Joint Mitnor Cave, which extends only about 20 m from the disused quarry face, lies in faulted and jointed Devonian limestone, and the cave system is underlain by a basin-like deposit of green volcanic tuff (Sutcliffe, 1977). Access to the cave is via the disused Higher Kiln Quarry which now houses the William Pengelly Cave Studies Centre.

Sutcliffe (1960) recorded the following stratigraphy from Joint Mitnor Cave:

3. Stalagmite floor, shattered and partly re-cemented (up to *c.* 0.5 m);
2. Loosely packed earth and stones, with numerous mammalian remains (cave earth and breccia) (up to *c.* 1.5 m);
1. Sterile waterlain sediments, much disturbed and locally consisting of finely laminated clay and silt (up to *c.* 1.5 m).

Sutcliffe (1960) notes that deposits similar in composition and texture to those in bed 1 were encountered in each of the trial pits excavated within Joint Mitnor Cave, as well as in similar locations elsewhere within the cave system, particularly within Baker's Pit Cave. Locally, these deposits are brecciated and overlie bedrock which shows no sign of speleothem growth; their maximum altitude is consistently at *c.* 64 m OD (Sutcliffe, 1960). Bed 2 is recorded as being thickest beneath the boulder-choke at the highest point of the Entrance Chamber, but thinning to < 0.3 m near the cave entrance. Sutcliffe describes this highly fossiliferous deposit as part of a talus cone, similar cones occurring elsewhere within the cave system. He notes that numerous waterlain pebbles occur in both beds 1 and 2, some having originated from Dartmoor.

Sutcliffe (1960) and Sutcliffe and Kowalski (1976) recorded the following mammalian remains from the cave earth/talus cone (bed 2) (nomenclature updated):

MAMMALIA

Lagomorpha

Lepus sp., hare

Rodentia

Arvicola terrestris cantiana (Hinton), extinct water vole

Microtus agrestis (Linné), field vole

Carnivora

Canis lupus Linné, wolf

Vulpes vulpes (Linné), red fox

Ursus cf. *arctos* Linné, brown bear

Meles meles Linné, badger

Crocuta crocuta (Erxleben), spotted hyaena

Panthera leo (Linné), lion

Felis sylvestris Schreber, wild cat

Proboscidea

Palaeoloxodon antiquus (Falconer & Cautley), straight-tusked elephant

Perissodactyla

Stephanorhinus (Dicerorhinus) hemitoechus (Falconer), extinct rhinoceros

Artiodactyla

Sus scrofa Linné, wild boar

Hippopotamus amphibius Linné, hippopotamus

Megaloceros giganteus (Blumenbach), giant deer

Dama dama (Linné), fallow deer

Cervus elaphus Linné, red deer

Bison priscus (Bojanus), extinct bison

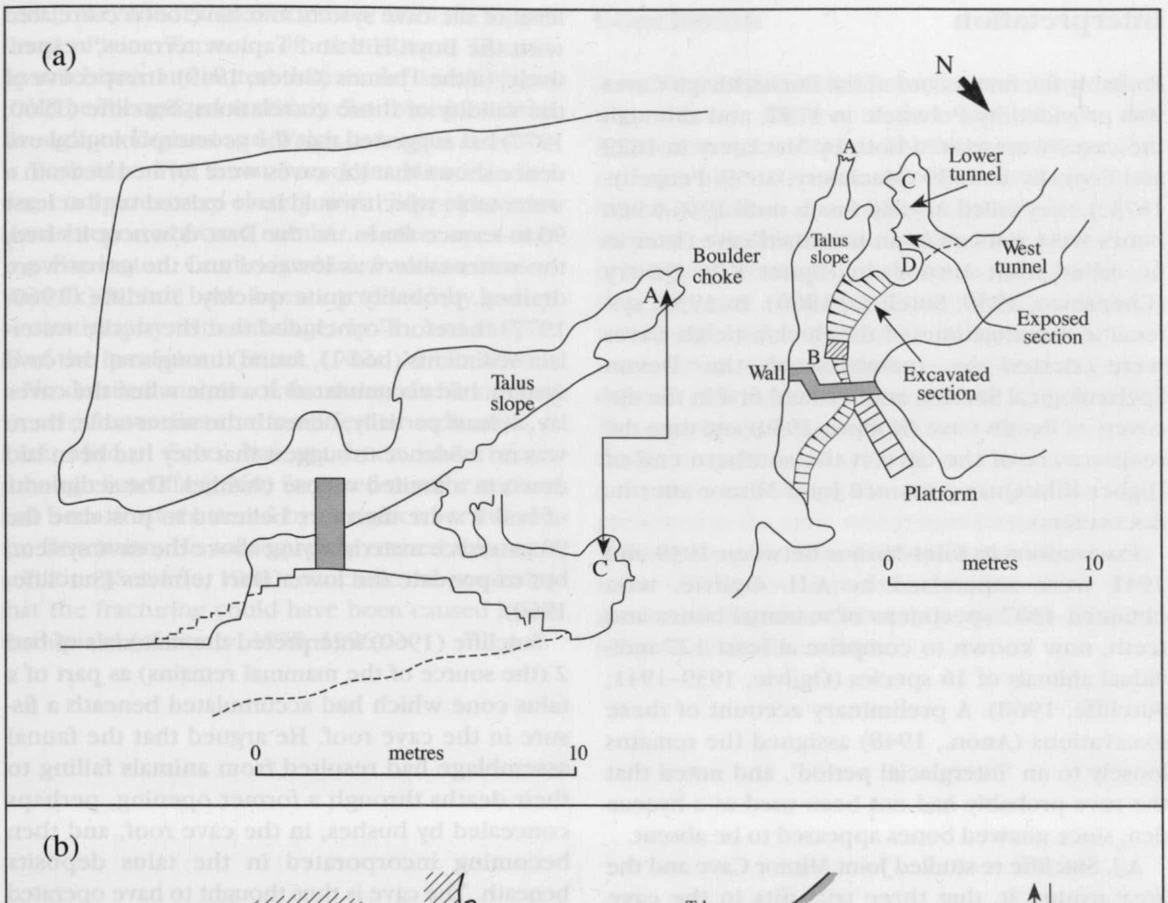

Figure 5.4 Joint Mitnor Cave, Buckfastleigh: (a) General elevation and plan. (b) Detail of excavated section. (Based on the work of A.J. Sutcliffe and adapted from Sutcliffe's original drawing and Sutcliffe's (1974) simplified section.)

Interpretation

Probably the first record of the Buckfastleigh Caves was provided by Polwhele in 1797, and although the caves were visited both by MacEnery in 1829 and Pengelly in 1859 (MacEnery, 1859; Pengelly, 1873c), they failed to yield fossils until 1936 when bones were noticed in an unnamed cave (later to be called Joint Mitnor) in Higher Kiln Quarry (Cheesman, 1959; Sutcliffe, 1960). In 1939, systematic investigations of the Buckfastleigh Caves were started by members of the Devon Spelaeological Society, and resulted first in the discovery of Reed's Cave (Hooper, 1950) and then the re-discovery of the cave at the southern end of Higher Kiln Quarry (named Joint Mitnor after its discoverers).

Excavations in Joint Mitnor between 1939 and 1941 were supervised by A.H. Ogilvie, who obtained 4307 specimens of mammal bones and teeth, now known to comprise at least 127 individual animals of 16 species (Ogilvie, 1939–1941; Sutcliffe, 1960). A preliminary account of these excavations (Anon., 1948) assigned the remains loosely to an 'interglacial period', and noted that the cave probably had not been used as a hyaena den, since gnawed bones appeared to be absent.

A.J. Sutcliffe re-studied Joint Mitnor Cave and the area around it, dug three trial pits in the cave during 1954–1955 (Sutcliffe, 1957), and re-examined the mammalian remains collected by Ogilvie. The most significant phase of excavation, however, dates from about 1959 onward, when the cave was set up as a demonstration. This work had already been started before the purchase of the quarry in 1961 and the establishment of the Pengelly Centre (Sutcliffe, 1966). During these excavations, a huge rock was removed with explosives and the roof reinforced, and the demonstration section established. Many bones were found at this stage (now housed in the Natural History Museum), but no new species were added except for the two rodents. Although largely unpublished, important documentation was undertaken, including drawing a detailed section of the deposits (Sutcliffe, 1966; Figure 5.4).

Sutcliffe (1960, 1977) regarded the relationship between the Higher Kiln Quarry Caves and the terraces of the River Dart as instructive in determining the history of development of Joint Mitnor Cave. The highest local terrace (the Upper Ambersham Terrace of Green (1949)) overlies the caves at a level of *c.* 90 m OD. The adjacent 60 m-level (and lower) terraces of the Dart, lie beneath the general level of the cave system and have been correlated with the Boyn Hill and Taplow terraces, respectively, of the Thames (Green, 1949). Irrespective of the validity of these correlations, Sutcliffe (1960, 1977) has suggested that the geomorphological evidence shows that the caves were formed beneath a water-table which would have existed until at least 90 m-terrace times. As the Dart downcut its bed, the water-table was lowered and the caves were drained, probably quite quickly. Sutcliffe (1960, 1977) therefore concluded that the sterile water-lain sediments (bed 1), found throughout the cave system, had accumulated at a time when the caves lay, at least partially, beneath the water-table; there was no evidence to suggest that they had been laid down in a limited vadose channel. The sediments of bed 1 were therefore believed to post-date the 90 m-terrace materials lying above the cave system, but to pre-date the lower Dart terraces (Sutcliffe, 1960).

Sutcliffe (1960) interpreted the materials of bed 2 (the source of the mammal remains) as part of a talus cone which had accumulated beneath a fissure in the cave roof. He argued that the faunal assemblage had resulted from animals falling to their deaths through a former opening, perhaps concealed by bushes, in the cave roof, and then becoming incorporated in the talus deposits beneath. The cave is thus thought to have operated as a natural pitfall trap in this respect, with the opening becoming blocked later by roof-fall materials.

Regarding the faunal remains, Sutcliffe (1960) concluded that the assemblage was composed only of mammals characteristic of warm climatic conditions, or of those with no specific climatic significance; cold-climate species were absent. The assemblage was therefore regarded as having accumulated during an interglacial, its homogeneity suggesting relatively rapid accumulation (Sutcliffe, 1960). Sutcliffe has argued that the faunal remains probably date from the warmest part of the Ipswichian (Eemian) Stage, citing the abundance of hippopotamus, ***Stephanorhinus (Dicerorhinus) hemitoechus*** and spotted hyaena, and the lack of horse and ***Stephanorhinus (Dicerorhinus) kirchbergensis*** (Jäger), as the principal evidence. He also notes that the remains of herbivorous mammals far outweigh those of carnivores, and that the cave does not appear to have been a hyaena den, the presence of the bones being best explained as the result of an 'accidental process of accumulation' (Sutcliffe, 1960).

Sutcliffe (1977) correlated the faunal remains from Joint Mitnor Cave with those from the Upper Flood Plain Terrace of the River Thames (Ipswichian), and noted that similar assemblages could be recognized at widely distributed localities throughout England and Wales, at least as far north as Yorkshire. The fauna from Joint Mitnor in fact also compares very closely with 'hippopotamus faunas' reported from a number of other open sites (e.g. Barrington, Cambridgeshire; Swanton Morley, Norfolk) which have been correlated by pollen biostratigraphy with substages Ip IIb, and early Ip III of the Ipswichian (Stuart, 1982a, 1982b, 1995).

No detailed analysis of the stalagmite floor (bed 3), which overlies the fossiliferous sediments at Joint Mitnor Cave, has yet been undertaken, although Sutcliffe (1960) favoured that the surface had been frost-shattered by periglacial activity in the Devensian. He subsequently revised this interpretation (Sutcliffe, 1966) to include the possibility that the fracturing could have been caused by an earthquake (cf. Straw, 1995, 1996).

Conclusion

Joint Mitnor Cave is significant for providing one of the richest known faunal assemblages of Ipswichian age in Britain. The fauna, of 18 species, includes hippopotamus, straight-tusked elephant, wild boar, fallow deer, spotted hyaena, lion, bear and some small mammals, making Joint Mitnor one of Britain's outstanding Pleistocene mammal localities. The cave contains a lower waterlain deposit which probably formed while the cave was at least partly below the water-table, and an overlying talus deposit rich in the bones and teeth of mammals. The animals are thought to have fallen to their deaths through a fissure in the cave roof. A permanent section through the deposits and fossils is preserved in the cave, which now forms part of the William Pengelly Cave Studies Centre. The importance of the cave deposits is heightened by their geomorphological relationship with the adjacent terraces of the River Dart.