Bacon Hole Cave

Highlights

This site shows an outstanding sequence of cold and temperate interglacial rocks and faunas. It has yielded the most complete faunal record for the Ipswichian and Early Devensian in Wales from a complex section.

Introduction

Bacon Hole [SS 559 868] is an important cave in Gower, preserving a sequence of deposits and faunal assemblages important for understanding Late Pleistocene events in Britain. The site contains one of the most detailed records of faunal change recorded at any Ipswichian Stage site in Britain. Bacon Hole has an unusually long history of research which commenced with the work of Wood (see Benson 1852; Falconer 1860, 1868). It was also mentioned by Prestwich (1892), Tiddeman (1900), Strahan (1907a) and George (1932, 1933b). The site became the focus of a controversy concerning possible Palaeolithic cave paintings (Sollas and Breuil 1912; R E Morgan 1913; W L Morgan 1913; Sollas 1924; Wheeler 1925; Garrod 1926). Archaeological finds were described by Williams (1939, 1941) and the site was partially re-excavated in 1943 by Allen and Rutter (1948). More recently, evidence has been discussed by Bowen (1970a, 1977a, 1977b, 1980a, 1981a), George (1970), Griffiths (1972), Sutcliffe (1976, 1981), Houlder (1977), Stringer and Currant (1981) and Turner (1981a, 1981 b). Detailed studies have been carried out by Stringer (1975, 1977a, 1977b), Harrison (1977), Bowen et *al.* (1984), Currant *et al.* (1984) and Henry (1984a). Most recently Stringer *et al.* (1986) have provided a detailed interpretation of the age and significance of the sequence at Bacon Hole. Bacon Hole is an important site for the correlation and classification of the marine sequences of western and southern Britain using amino acid geochronology (Bowen *et al.* 1985; Bowen and Sykes 1988).

Description

Bacon Hole is a large terrestrial cave formed along a near vertical fault in Carboniferous Limestone. The cave opens onto a sloping rock platform at *c.* 11.5m OD (Stringer *et al.* 1986) upon which a sequence of marine and terrestrial sediments occurs. There is little evidence for channelling or reworking of the deposits, and the boundaries between units are unusually clear for cave deposits (Currant *et al.* 1984). In addition there is a remarkable consistency of deposition across the platform into the cave, which assists correlation and interpretation. The following units are recognised (Currant *et al.* 1984; Stringer *et al.* 1986) —

10 Cemented Breccias

9 Upper Cave Earth

8 Upper Sands

7. Grey Clays, Silts and Sands

6 Shelly Sand

5 Sandy Cave Earth

4 Sandy Breccio-Conglomerate

3 Coarse Orange Sands

2 Coarse Grey Sands

1 Basal Pebbles

Schematic sections through the platform and cave sequences are shown in (Figure 4).

The first excavation at Bacon Hole by Wood was subsequently documented by Benson (1852) and Falconer (1860, 1868). These workers noted a sequence of —

9 Dark superficial earth (with *Bos* sp., *Cervus* sp., *Vulpes vulpes,* reindeer antlers, roebuck, a variety of littoral molluscs and pieces of pottery)

8 Stalagmite (with *Ursus* sp.)

7 Limestone breccia and stalagmite (with bones of *Ursus* and *Bos*)

6 Stalagmite (enveloping an elephant tusk)

5 Ochreous cave earth and limestone breccia (with *Palaeoloxodon antiquus* Falconer & Cautley, *Dicerorhinus hemitoechus* (Falconer), *Crocuta* sp., *Canis lupus, Ursus spelaeus, Bos* sp. and *Cervus* sp.)

4 Blackish sand (with bones of *Palaeoloxodon antiquus, Meles meles* (L.) and *Mustela putonus* (L.)

3 Stalagmite

2 Marine sand (with *Littorina* sp. shells, bones of *Arvicola* sp. and birds)

1 Limestone floor Interpretation

Prestwich (1892) noted cemented fragments of raised beach near the entrance to the cave but was unclear about the relative ages of the Pleistocene deposits concluding " that the Gower caves have probably been filled up with their mammalian remains since the deposition of the boulder clay". Such a conclusion was reversed by Tiddeman (1900) and Strahan (1907a) who suggested that the raised beach was probably pre-glacial or interglacial and that the overlying bone beds were of similar age; both formations pre-dating deposition of glacial drift in the local area. Strahan (1907 a) observed that such an interglacial age corresponded well with the 'warm' fauna recovered from the beds, and alluded to the possibility that the 'colder' fauna excavated by Wood, might have occurred in significantly younger beds not associated with the interglacial phase. Similarly, George (1932, 1933b) maintained that the raised beach at Bacon Hole was of pre-glacial age, and correlated it with the *Patella* Beach.

During the early part of the twentieth century, Bacon Hole featured in a controversy concerning the possible existence of Palaeolithic paintings within the cave. Sollas and Breuil (1912) had claimed that ten red bands on the wall of the cave were painted by Aurignacian Man, and that they were the oldest of their kind in Britain. Some workers, however, claimed that the markings had been formed naturally from oxides within the rock (R E Morgan 1913; W L Morgan 1913; Wheeler 1925; Allen and Rutter 1948), and Garrod (1926) discussed the possibility that they had been produced fraudulently during more recent years. Sollas (1924) maintained, however, that the painted bands were genuine. The status of the cave markings remains obscure, although some authors (for example, Bowen 1970a) allude to the possibility that they are genuine. The archaeological interest of the site was further enhanced by Williams' (1939, 1941) descriptions of finds of Iron Age pottery from the cave floor.

In 1943, Allen and Rutter excavated a small mound outside the cave as part of a comprehensive survey of the Gower caves (Allen and Rutter 1948). They discovered teeth, bones and coprolites; the coprolites they attributed to hyaenas, and their restricted occurrence was seen as evidence that the species may have been relatively rare in Bacon Hole. Their study confirmed the stratigraphical observations of Wood and Benson, and produced additional fossil specimens further suggesting an interglacial age for the older deposits in the cave.

Work in Gower by Bowen, since 1965, has further established the importance of the area for subdividing and classifying the Pleistocene stratigraphy of Wales and the Irish Sea Basin. From a re-examination of the Pleistocene stratigraphy in coastal sections and caves around the Gower coast, Bowen (1970a) suggested that the simplest interpretation of the sequences at Bacon Hole (and Minchin Hole), was to regard the 'warm' beds as Ipswichian in age, and the overlying

'cold' beds as Devensian. Such an interpretation has largely been substantiated by more recent detailed examinations of the site (for example, Stringer 1977b; Bowen et *al.* 1984; Henry 1984a; Stringer *et al.* 1986).

In addition to recovering numerous fossils including bison or giant ox, cave hyaena, bank or field vole and various marine and terrestrial molluscs from deposits on the shore platform just outside the cave, Griffiths (1972) made a notable discovery of pieces of fossil ivory (mammoth?) which, he considered, had been shaped by Palaeolithic Man. As a result of this excavation, he attributed the recovered remains to an interstadial phase within a glaciation, presumably during the Devensian Stage.

Excavations in 1974 and 1975 in superficial deposits on the rock platform outside the cave, yielded abundant remains of interglacial fossil mammals, possibly representing the early, middle and late parts of an interglacial (Ipswichian) climatic cycle (Stringer 1975).

Further excavation and additional information led Stringer (1977a, 1977b) to revise the established stratigraphy of the site. He recorded a sequence of:

8 Cemented Breccias (not then excavated)

7 Upper Cave Earth

6 Upper Sands

5 Coarse Brown Sands

4 Grey Clays, Silts and Sands

3 Sandy Cave earth

2 Sandy Breccio-Conglomerate

1 Basal Sands

Stringer demonstrated that the Basal Sands were probably marine in origin, especially towards the base where they contained rounded pebbles and marine molluscs. Scanning Electron Microscopy (SEM) showed that the beach also contained reworked sand from glacial sources. Faunal elements such as horse and northern vole were indicative of open-country, boreal conditions; and a restricted fauna of land snails suggested an environment of bare cliff faces and scree slopes. The presence of fox (Stringer 1977b) and razorbill (Harrison 1977), however, paint a slightly less bleak picture. Stringer concluded that the Basal Sands (his bed 1) represented a period of high sea- level, perhaps during the early part of an interglacial cycle. The overlying Sandy Breccio-Conglomerate (bed 2) generally indicated more typical 'fully' interglacial conditions with mammals of mixed temperate oak forest (for instance, red deer, wood mouse, field vole and bank vole). The succeeding Sandy Cave Earth (bed 3) was considered to represent a more typical cave entrance deposit, but still with a high proportion of marine characteristics. The mammal, fish and bird faunas, the latter with curlew, dunlin, starling and Cory's shearwater (Harrison 1977), were indicative of generally warm conditions during deposition of the bed. Cory's shearwater was displaced at least 10° north of its present range, possibly indicating warmer conditions than at present.

The Grey Clay, Silts and Sands (bed 4) provided rich fossil material including over 100 coprolites, probably of hyaena. Stringer confirmed the presence of giant ox and bison from this bed and also noted the occurrence of northern vole and bean goose (Harrison 1977) which he argued showed a return to more boreal conditions, although several temperate species such as badger, shrew and woodmouse were also recorded. Stringer noted that this bed had contained the 'polished' bones which he suggested had been used to dress animal skins. Houlder (1977) believed these 'tools' represented the oldest evidence (then available) of Man's presence in Wales.

The succeeding Coarse Brown Sands (bed 5) contained (Stringer 1977b) a 'distinct small mammal assemblage', although the significance and nature of the bed was not established. The ivory artefact described by Griffiths (1972) was

thought to have originated from this bed (Stringer 1977b). The overlying Upper Sands (bed 6) contained a mixture of marine-derived and windblown sand grains, with a foraminiferal assemblage typical of modern British coastal waters.

Stringer also described new finds from the Upper Cave Earth (bed 7), including wolf and hyaena. The faunal assemblage showed a mixture of temperate (for instance, red deer and straight-tusked elephant) and more boreal (for instance, northern vole) species, although the land snail fauna was typically interglacial and indicated an environment of local woodland and scrub. Beds 17 were traced under a series of cemented breccias (bed 8) which Stringer considered to be thermoclastic screes, accumulated at the cave mouth during the coldest phases of the Devensian Stage. Subsequent work (Currant et *al.* 1984; Stringer *et al.* 1986) recorded a fauna from the screes including reindeer, brown bear and a new record of glutton (*Gulo gulo* (L.)). Stringer (1977b) concluded that the deposits at the cave entrance were of Ipswichian age and that their fossil fauna was evidence for environmental changes during that stage.

Following a paper (Turner 1981a) on the importance of hyaena (*Crocuta crocuta* Erxleben), as a bone accumulating agent during the Ipswichian in Britain, Stringer and Currant (1981) used the faunal evidence from Bacon Hole to refute Turner's claims. They noted that hyaena was absent or poorly represented in a fauna of otherwise Ipswichian character at the site, but that it is associated later in the sequence with deposits considered to post-date the warmest part of that stage. This, they believed, refuted Turner's hypothesis on the 'unique' role of hyaenas in producing bone accumulations in caves, and the restricted occurrence of *Crocuta crocuta* in Britain during the Ipswichian Stage. In reply, Turner (1981b) noted that other animals could have been responsible for the bone accumulations at some sites (for instance, wolf or bear), but emphasised the overwhelming evidence pointing to hyaena as the most probable and important single agent.

Following Stringer's (1975, 1977a, 1977b) interpretation of the sequence at Bacon Hole, considerable efforts were made to establish a more precise chronological framework for the deposits. Bowen et *al.* (1984) obtained amino acid ratios from shells of *Patella vulgata* and *Littorina* found in a) the Basal Sands, b) the Sandy Breccio-Conglomerate, c) the Sandy Cave Earth and d) the Grey Clays, Silts and Sands. Their results confirmed that all the stratigraphic units up to and including the Grey Clays, Silts and Sands were of Ipswichian age.

Currant *et al.* (1984) and Stringer et *al.* (1986) presented a comprehensive series of Uranium-series age determinations (Table 3) from Bacon Hole, which place the interglacial fauna at the site between *c.* 130,000 and 80,000 BP. They adopted a slightly revised site stratigraphy and recognised a coarse lag deposit at the base of the succession (the Basal Pebbles) and an additional bed (the Shelly Sand) between the Sandy Cave Earth and the Grey Clays, Silts and Sands — see site description.

By combining all the available data, especially from Henry (1984a) and Stringer *et al.* (1986), the following sequence of Pleistocene events at Bacon Hole can be reconstructed. Deposits accumulated before Oxygen Isotope Sub-stage 5e, as shown by a Uranium-series age determination of 175,000 ± 19,000 BP on a stalagmite layer capping altered sediments in a cleft in the cave floor. These sediments only occur at one location in the cave and appear to have been largely removed elsewhere by marine scouring during a period of pre-Oxygen Isotope Sub-stage 5e high sea-level (perhaps represented by the Basal Pebbles (bed 1); Bowen *et al.* 1985). The succeeding Coarse Grey and Orange Sands (beds 2 and 3) were deposited during a period of cool dry climate with relatively open vegetation. A rise in relative sea-level accompanied by a rise in temperature and humidity saw deposition of the Sandy Breccio-Conglomerate (bed 4), the Sandy Cave Earth (bed 5) and the Shelly Sand (bed 6). The Sandy Breccio-Conglomerate may represent a storm beach, marginally higher than its modern day equivalent, and closely related on altitudinal, lithological, aminostratigraphic and faunal grounds with the +2m *Patella* Beach in the nearby Minchin Hole. Stringer *et al.* (1986) provided a date of *c.* 122,000 BP (from broken stalagmite fragments, not *in situ,* from the top of bed 5) for this marine transgression, which they claimed was the first direct correlation of a British Ipswichian fauna with the high sea-level of Oxygen Isotope Sub-stage 5e. Amino acid ratios from the terrestrial snail *Cepaea nemoralis* (L.), allowed correlation of the Sandy Cave Earth (bed 5) at Bacon Hole with the interglacial deposit at Tattershall, Lincolnshire (Hughes 1984).

Stringer *et al,* (1986) considered that the Grey Clays, Silts and Sands (bed 7) marked a change in the environment, with falling sea-level and temperature. Mammoth *Mammuthus primigenius* (Blumenbach) is recorded for the first time in this bed, and temperate birds of the preceding beds are replaced by species now only known as winter visitors to Britain. The Upper Sands (bed 8) indicate a drier phase, with deposition of marine-derived wind-blown sediments. Stringer *et al.*

(1986) concluded that the Upper Cave Earth (bed 9) was deposited during a period of lower sea-level than the superficially similar Sandy Cave Earth (bed 5). The former (bed 9) contains a restricted mammal fauna of interglacial character, a minimum age for which is indicated by a Uranium-series date of c. 81,000 BP obtained from stalagmite enclosing a tusk of *Palaeoloxodon.* This phase probably represents an Early Devensian interstadial, time-equivalent to Oxygen Isotope Sub-stage 5a. Stringer *et al.* (1986) noted that *Palaeoloxodon* and *Dicerorhinus* continued to be unusually abundant in this Early Devensian fauna. A date of *c.* 13,000 BP for broken stalagmite from the uppermost part of the Cemented Breccia (bed 10), provides a minimum age for the more typically cold Devensian fauna within these sediments.

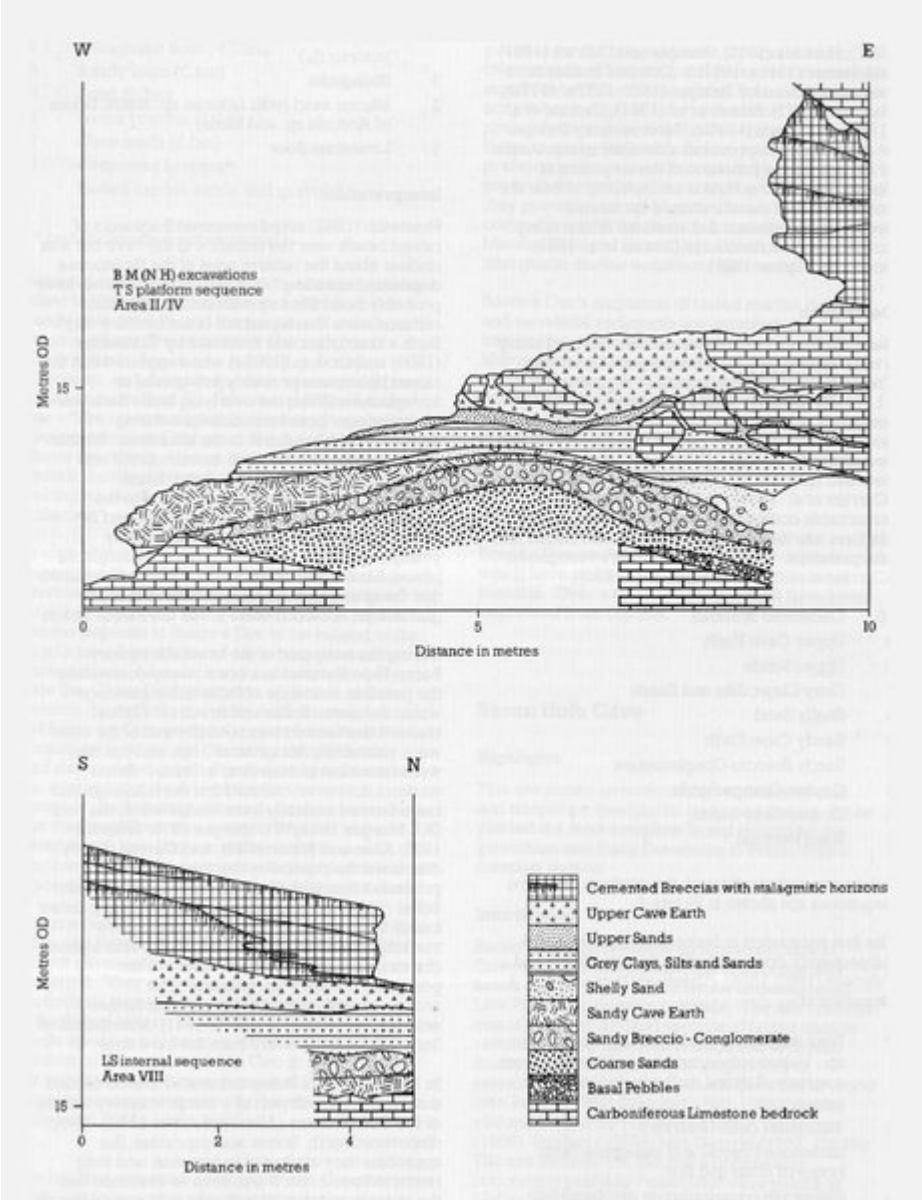
The faunal sequence at Bacon Hole, therefore, would appear to record a number of cycles similar to those in the deep-sea oxygen isotope record (Sub-stages 5a, 5c and 5e). A boreal environment with relatively low sea-level was followed by warmer conditions in Oxygen Isotope Sub-stage 5e; this phase, with sea-level close to that of the present day, has been dated at *c.* 122,000 BP. The following deposits, containing less typically interglacial faunas, are associated with lower sea-levels until around 80,000 BP (Oxygen Isotope Stage 5a?). Subsequently, breccias with a 'cold' fauna were deposited (Stringer *et al.* 1986).

The sequence at Bacon Hole Cave (and nearby Minchin Hole Cave) presents a unique opportunity in Britain to correlate sea-level and palaeotemperature data with the deep-sea oxygen isotope record. The amino acid data and lithostratigraphy are more complete at Minchin Hole Cave, but the faunal evidence from Bacon Hole is more detailed, and it has provided unique information concerning the nature and complexity of the Ipswichian–Devensian transition. The dating of specific beds in the sequence by amino acid and Uranium-series techniques, has contributed towards a geochronological framework for British evidence during the Ipswichian and Devensian Stages (Bowen and Sykes 1988; Bowen 1989b).

Conclusions

Bacon Hole Cave is one of the most important sites in Europe. It is the only site in Britain which contains evidence for sub-dividing the important period of time between 130,000 and 70,000 years ago. That time period is important because it led directly to the last major ice age. It provides important evidence showing how the world moves from an interglacial into an ice age. As such it may be used as an analogue for future changes in climate. A full range of modern techniques has been applied at Bacon Hole Cave. The evidence is of high quality, it is plentiful and well preserved, and is exceptional by international standards.

References



(Figure 4) Pleistocene sequence at Bacon Hole Cave (from Currant et al. 1984)

Sample No.	Age	Corrected Age	Stratigraphic significance
1978–801 :01	14,000 ± 2,000	13,000 ± 3,000	Broken block of surface stalagmite giving minimum age for Devensian fauna
:02	18,600 ± 1,999	12,800 ± 1,700	
1981–250	81,000 ± 18,000	–	Minimum age for the interglacial elements in Upper Cave Earth (bed 9)
1981–212 :01 (top)	129,000 ± 16,000	–	All are broken blocks of stalagmite floor incorporated into Shelly Sand (bed 6)
:02 (middle)	136,000 ± 23,000	125,000 ± 26,000	
:03 (bottom)	142,000 ± 27,000	129,000 ± 30,000	
1981–252 :02	116,000 ± 18,000	107,000 ± 21,000	This stalagmite probably formed on the underlying Sandy Cave earth (bed 5)
:01	122,000 ± 11,000	–	
Mean of last 5 determinations	127,000 +9,000 -8,000	122,000 ± 9,000	These dates relate to the main interglacial fauna and the last major Pleistocene marine transgression at the site

(Table 3) Uranium-series age determinations on stalagmite samples from Bacon Hole.