Bouldnor Cliff, Isle of Wight

[SZ 375 902]–[SZ 403 919]

Introduction

Bouldnor Cliff exposes the Bembridge Limestone Formation and the Bouldnor Formation (Figure 3.21). The unstable nature of the cliffs, leading to a high rate of coastal erosion, make this an excellent site for fossil collecting. Bouldnor Cliff is important globally as a source of Oligocene reptiles, birds and mammals. It is a classic British site for the larger Paleogene mammals, notably anthracotheres (e.g. Cooper, 1925). More recently, the smaller rodents have been described by Bosma (1974) and Bosma and de Bruijn (1979).

Description

The coastal section at Bouldnor Cliff (including Hamstead Cliff and Ledge) exposes the Bembridge Limestone Formation and all of the overlying Bouldnor Formation in a synclinal structure (Figure 3.21). Although the coastal section is long (3.2 km), exposure is intermittent owing to slumping. The Bembridge Limestone Formation crops out in the eastern parts of the section [SZ 401 920] and is responsible for the 'Hamstead Ledge' feature. The Bembridge Marls Member is best-exposed in the adjacent cliff and foreshore, whereas the Hamstead and Cranmore members form the cliff and foreshore farther west (Insole and Daley, 1985).

The section (Table 3.6) is taken from Benton and Spencer (1995, p. 296) and is based on White (1921), Daley (1973), Daley and Edwards (1974), Daley and Insole (1984), Insole and Daley (1985) and Daley (1999b).

Mammal remains, together with fish, turtles and crocodiles, occur at several levels in the Bouldnor Formation: near the top of the Bembridge Marls Member and within the Hamstead Member, both below and above the *Nematura* Bed. They have been collected from both cliff and foreshore exposures and many arc found loose on the beach with no clear provenance, although preservation can often be a guide. From the Bembridge Marls at Yarmouth several species of large mammal typify the *sue–vicum–frohnstettense* Zone (Hooker 1987) and Mammal Paleogene Reference Level MP20 (Schmidt-Kittler, 1987), namely *Anoplotherium* sp., *Palaeotherium medium suevicum* and *Plagiolophus major* (Hooker *et al.,* 2004).

Lower parts of the Hamstead Member, below the *Nematura* Bed, contain similar large mammals, typical of the endemic Late Eocene faunas of Europe, namely *Anoplotherium commune, A. latipes, Xiphodon gracilis, Plagiolophus minor, P. major, Palaeotherium magnum, P. muehlbergi and P. curtum frohnstettense.* The last is restricted to the *suevicum–frohnstettense* Zone and MP20. Thanks to screenwashing techniques, a fauna of small mammals has also been found in these strata. Key amongst these is the theridomyid rodent *Theridomys bonduelli*, whose only other correctly recorded occurrence is in the Marnes Blanches de Pantin in the Paris Basin, affording a secure correlation (Hooker et al., 2004). This correlation integrates with that of the Nematura Bed and Argiles Vertes de Romainville dated on the dinoflagellate cysts (Liengjarern et al., 1980), which form the next higher unit in both basins.

(Table 3.6) Section for Bouldnor Cliff (after Benton and Spencer, 1995)

	Thickness (m)
Bouldnor Formation	
Cranmore Member (Upper Hamstead Beds of White, 1921)	
Corbula Beds	5.8
Cerithium Beds	3.4
Hamstead Member (Lower Hamstead Beds of White, 1921)	
Green and mottled clays, with lignite beds and shell beds	c. 25

Water-Lily Bed: laminated lignite with seeds, palm leaves, water-lily leaves and molluscs	0.6
Green and red marls (much obscured)	20.7
White Band: green clays with white shell-marls	1.8
Green clay with ironstone nodule band (much obscured)	10.8
Nematura Bed: black lignitic clay, full of gastropods	0.9
Green and black clays, with bivalves and gastropods	8.1
Black Band: lignite, full of *Viviparus* and *Unio*	0.5
Bembridge Marls Member (Bed notation from Daley, 1973)	
HAM XXXI–XXXIV: freshwater clays	1.8
HAM XXX: lignite with seeds and molluscs	0.1
HAM XXVI–XXIX: clays with seeds and molluscs	5.7
HAM XXIII–XXV: lignite and clay, rich in water-plant seeds, leaf fragments and gastropods	2.0
HAM XX–XXII: freshwater clays and silts	2.0
HAM XIX: green clays and white marls, with bivalves	0.3
HAM XVI–XVIII: green muds and lignite band	1.8
HAM XV: black clay with gastropods	0.2
HAM XI–XIV: muds and silts, with bivalve band	3.6
HAM VI–X: grey and blue-green laminated clays, with brackish water bivalves and gastropods	2.7
HAM V: greenish-grey clay with bands containing *Melanoides acuta, Serpula* sp. and *Viviparus lentus*	0.3
HAM I–IV: grey and black clays with Shelly partings and bands containing bivalves and gastropods; thin shell bed with *Ostrea* at the base (Bembridge Oyster Bed)	0.9
Rests on Bembridge Limestone Formation	

Upper parts of the Hamstead Member above the *Nematura* Bed yield a very different fauna. Amongst the large animals, there are no more anoplotheres, xiphodonts or palaeotheres. Amongst the smaller elements, the pseudosciurid rodents, the omomyid primates, the amphilemurid lipotyphlans and nearly all of the nyctitheres have disappeared. In place of the old large mammals are artiodactyls of the families Anthracotheriidae (*Bothriodon, Elomeryx* and *Anthracotherium*) and Entelodontidae and a pecoran (advanced ruminant), and perissodactyls of the family Rhinocerotidae (*Ronzotherium*) (Hooker *et al.,* 2004). Of the rodents, alongside the theridomyids and glirids (dormice), which persisted undiminished, appeared the first European beavers (*Asteneofiber*), hamsters (*Atavocricetodon*) and the extinct eomyids (Bosma, 1974; Bosma and de Bruijn, 1979). Also amongst the fauna of smaller mammals are the first European hedgehogs (*Tetracus*) and bears (a dog-sized amphicynodontine). The upper Hamstead Member has also yielded the last adapid primate in the world (*Leptadapis* sp.) and the last British nyctithere (one specimen each). In contrast, the marsupials continued almost unchanged.

The anthracotheres, distant hippo relatives, are the best-known elements of the Bouldnor Cliff post 'Grande Coupure' fauna, as they are the only large early Tertiary mammals that are relatively common fossils. Their taxonomy and nomenclature is complex (Owen, 1848c; Lydekker, 1884b, 1885a; Cooper, 1925, 1926a; Lavocat, 1952; Hellmund, 1992; Hooker, submitted). Rare elements represented by only a few isolated teeth are the giant pig-like entelodontid *Entelodon* (Brunet, 1979) and the first British true rhinoceros *Ronzotherium* (Ford, 1972).

Shark remains also have been reported from the *Cerithium* and *Corbula* beds in the brackish and marine Cranmore Member (Hooker *et al.,* 1980), but no mammals from those levels.

Fauna

The mammalian fauna from the Hamstead Member at Bouldnor Cliff, consisting of 44 species, is listed here. It is based on information on the rodents from Bosma (1974) and Bosma and de Bruijn (1979), with nomenclatural changes from

Vianey-Liaud (1994), Freudenthal (1996) and an updated list by Hooker *et al.,* (2004). The letters (L) and (U) after names distinguish between occurrences in lower and upper parts of the Hamstead Member, respectively.

MAMMALIA

Marsupialia

Herpetotheriidae

Amphiperatherium exile Gervais, 1852 (L,U)

Amphiperatherium minutum (Aymard, 1846) (U)

Amphiperatherium sp. (L, U)

Peratherium cuvieri (Fischer, 1829) (L)

Peratherium elegans (Aymard, 1846) (U)

Peratherium cf. *perrierense* Crochet, 1979 (U)

Rodentia

Pseudosciuridae

Suevosciurus fraasi (Major, 1873) (L)

Theridomyidae

Pseudoltinomys cuvieri (Pomel, 1853) (L)

Pseudoltinomys gaillardi (Stehlin and Schaub, 1951) (U)

Theridomys bonduelli (Lartet, 1869) (L)

Isoptychus margaritae (Vianey-Liaud, 1989) (U)

Gliridae

Glamys fordi (Bosma and de Bruijn, 1979) (L, U)

Bransatoglis planus (Bahlo, 1975) (L)

Bransatoglis micio (Misonne, 1957) (U)

Eomyidae

Eomys sp. (U)

Cricetidae

Atavocricetodon atavus (Misonne, 1957) ($^{1–1}$)

Castoridae

Asteneofiber sp. (U)

Lipotyphla

Talpidae

?Eotalpa sp. (L)

Myxomygale cf. *antiqua* Filhol, 1890a (U)

Erinaceidae

Tetracus aff. *nanus* (Aymard, 1846) (U)

Plesiosoricidae?

Butselia biveri Quinet and Misonne, 1965 (L, U)

Chiroptera

Vespertilionidae

Stehlinia minor (Revilliod, 1922) (U)

Stehlinia gracilis Revilliod, 1919 (U)

Archonta undiff.

Nyctitheriidae

Paradoxonycteris tobieni (Sigé, 1976) (L, U)

Amphidozotherium aff. *cayluxi* Filhol, 1877 (L)

Primates

Adapidae

Leptadapis sp. (U)

Pantolesta

Pantolestidae

Dyspterna woodi Hopwood, 1927 (L, U)

Carnivora

Ursidae

?Amphicynodon sp.

Creodonta

Hyaenodontidae

Hyaenodon cf. *dubius* Filhol, 1873 (U)

Artiodactyla

Entelodontidae

Entelodon magnus Aymard, 1846 (U)

Anthracotheriidae

Elomeryx porcinus (Gervais, 1852) (U)

Bothriodon velaunus (Cuvier in de Blainville, 1846) (U)

Anthracotherium alsaticum Cuvier, 1822 (U)

Choeropotamidae

Tapirulus sp. (U)

Anoplotheriidae

Anoplotherium commune Cuvier, 1804 (L)

Anoplotherium latipes (Gervais, 1852) (L)

Xiphodontidae

Xiphodon gracilis Cuvier, 1822 (L)

Pecora

Pecora indet. (U)

Perissodactyla

Palaeotheriidae

Palaeotherium magnum Cuvier, 1804 (L)

Palaeotherium muehlbergi Stehlin, 1904 (L)

Palaeotherium curtum frohnstettense Franzen, 1968 (L)

Plagiolophus minor (Cuvier, 1804) (L)

Plagiolophus major (Brunet and Jehenne, 1989) (L)

Rhinocerotidae

Ronzotherium cf. *romani* Kretzoi, 1940 (U).

A distinct change in the nature of the mammal faunas high in the early Tertiary strata in the Isle of Wight was noticed in the pioneering years (e.g. Forbes, 1856). However, it was not until early in the 20th century that the Swiss palaeo-mammalogist H.G. Stehlin (1910), with a European perspective, recognized the scale and significance of this faunal turnover, which he termed the 'Grande Coupure' (meaning 'big break'). During most of the Eocene Epoch, Europe had been a series of islands, intermittently linked, but separated by seaways from other continents. European mammal faunas quickly became endemic and, when Europe and Asia became reconnected early in the Oligocene Epoch, Asian species dispersed into Europe and much of the European endemic fauna (e.g. most palaeotheres, anoplotheriid, xiphodontid and choeropotamid artiodactyls, nyctitheres and primates) became extinct. How much the extinction was due to competition with the newcomers and how much to climatic change (this time was also marked by the first major

glaciation of Antarctica in the Cenozoic Era) is still unclear (Hooker *et al.,* 2004).

Until recently, the 'Grande Coupure' in the Isle of Wight was thought to occur between the Bembridge Marls and Hamstead Members of the Bouldnor Formation (e.g. Forbes, 1856; Stehlin, 1910; Hooker, 1992). Intensive collecting, especially using screenwashing, at a number of levels in the Bouldnor Formation has shown that the 'Grande Coupure' is in fact within the Hamstead Member (Hooker *et al.,* 2004). Moreover, a number of taxa previously thought to occur only after the 'Grande Coupure' (e.g. *Glamys fordi, Butselia biveri* — see Bosma and de Bruijn, 1979; Butler 1972) have been found to pre-date the event, but this does not include any taxa with a clear Asian origin. Stehlin (1910) deduced his 'Grande Coupure' from study of continental European faunas, many of which occur in isolated localities, including fissure fillings, where superposition cannot easily be demonstrated. The Bouldnor Cliff section is thus unique both in having a continuous, well-exposed succession across this faunal divide and in having several discrete levels with a diversity of large and small mammal remains (Hooker *et al.,* 2004).

The Bouldnor Cliff sections have provided the type specimens of two species: *Dyspterna woodi* Hopwood, 1927, and *Glamys fordi* (Bosma and de Bruijn, 1979).

Interpretation

The sediments preserved at Bouldnor Cliff are indicative of low-energy conditions and probably were deposited in a mainly lagoonal-lacustrine complex. Salinity ranged from brackish to freshwater. At times the water levels were low and desiccation cracks formed, for example in the lower sections of the Bembridge Marls Member (Daley, 1973). Daley (1973) distinguished three sedimentary environments in the Bembridge Marls Member: estuarine deposits in the lower part, passing up into lagoonal mudstones, and then floodplain and lacustrine sediments at the top. Collinson (1983b) reinterpreted Daley's floodplain lake environment as the upper reaches of a lagoon where salinities had dropped below 3 ‰.

The sample of mammal specimens from the upper part of the Hamstead Member at Bouldnor Cliff includes a relatively high proportion of large animals, which suggests an open habitat (Hooker, 1992). The distribution of dietary preferences and locomotory styles among the mammals suggests a moderately wooded woodland–bushland setting.

The dating of this dominantly non-marine sequence is complex. However, using the combination of a number of different markers (dinoflagellate cysts, mammals and sea-level changes), it is possible to correlate with successions in the Paris and Belgian basins, which have more marine intervals. From these areas, calibration with the standard marine sequences is possible (Liengjarern *et al.,* 1980; Aubry, 1986; Brinkhuis and Visscher, 1995; Steurbaut, 1992). It suggests that the Eocene–Oligocene boundary lies approximately between the Bembridge Limestone and Bembridge Marls and that the 'Grande Coupure' is therefore within the Early Oligocene (Hooker *et al.,* 2004).

Comparison with other localities

The Bembridge Marls and lower Hamstead members are assigned to the *suevicum–frohnstettense* Zone (Hooker, 1992; Hooker *et al.,* 2004) and Mammal Paleogene Reference Level MP20 (Schmidt-Kittler, 1987). As such, they are age-equivalent of continental European mammal faunas in Spain (Huermeces del Cerro, Sierra Palomera, Villarrosano 1, 12), France (St Capraise-d'Eymet, Tabarly, Baby 2, Villeneuve-la-Comptal, Paris Basin Marnes supragypseuses) and Germany (Frohnstetten, Bernloch 1A, Weissenburg 2). The lower Hamstead fauna is specifically age equivalent of the Marnes Blanches de Pantin in the Paris Basin on the shared presence of *Theridomys bonduelli.*

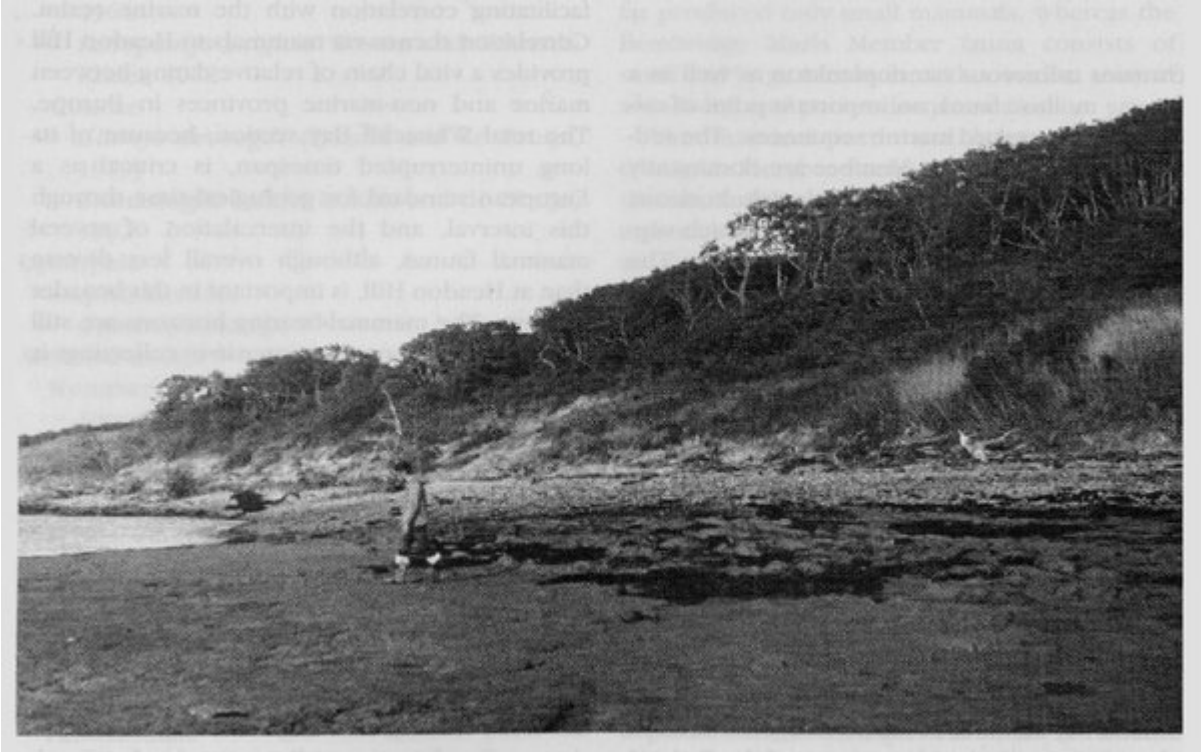
The upper Hamstead Member at Bouldnor Cliff is assigned to MP21 (Schmidt-Kittler, 1987) and as such is the age-equivalent of a number of continental European mammal faunas, in Spain (Calaf, Montalban 8, Olalla 4A, Santpedor, Espinosa de Henares), France (Ronzon, Ravet, Ruch, Lagny-Thorigny, Aubrelong 1, Soumailles), Belgium (Hoogbutsel), Germany (Mohren 19, 20, Ehrenstein 1B) and the Czech Republic (Detan (BiochroM'97, 1997)). Its fauna is particularly similar to that occurring at Hoogbutsel (Belgium), with which it shares two rodent species and one lipotyphlan species (Bosma, 1974; Butler, 1972), and with Lagny-Thorigny (Paris Basin) and Ronzon (Central France), where the distinctive

anthracothere *Bothriodon* also occurs (Cavelier, 1979).

Conclusions

The sequence at Bouldnor Cliff is the only one in Europe that shows a well-exposed, superposed succession of multiple pre- and post-'Grande Coupure' mammal faunas, thus accurately documenting the major European faunal turnover just after the Eocene–Oligocene boundary. For this it is important internationally. It is the type locality for two mammal species. Although the cliff sections are much subject to slipping, washing by the sea continues to yield fresh sections and material.

References



(Figure 3.21) The fossiliferous Bembridge Limestone Formation and Bouldnor Formation at Bouldnor, Isle of Wight.

	Thickness (m)
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Rests on Bembridge Limestone Formation	

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