# Bouldnor, Hampshire

[SZ 382 907]

## Introduction

The cliff section in the Hamstead Member within the upper part of the Bouldnor Formation in the Solent Group at Bouldnor on the Isle of Wight straddles the Eocene–Oligocene boundary. The site has long been known for its diverse fossil biota of vertebrates (reptiles, mammals, birds) along with plant remains (Cleat *et al.,* 2001) and a variety of 'shelly' invertebrates, especially gastropods. However, modern work shows that this member also contains an insect fauna associated with freshwater ostracods and plant fossils of early Oligocene (Rupelian) age (Jarzembowski, 1980b). This is the youngest known Tertiary insect fauna in the UK.

At least four insect orders are represented here — Coleoptera, Hymenoptera, Diptera and Hemiptera distributed in at least six families.

The fossils occur in fine-grained sideritic concretions eroded from the Hamstead Member and scattered over the foreshore by wave action for about a kilometre east of national grid reference [SZ 377 904].

Conservation of the site is essential to enable systematic collecting and research on this first British insect fauna of unequivocal early Oligocene age. The site offers the opportunity to study the development of nearshore and land-based communities especially the plants, mammals and insects across the Eocene–Oligocene transition, a time of major global climate change. The level at which the insects occur can now be more exactly determined at above the 'Grand Coupure' and therefore also above the first Oligocene glaciation and its associated faunal changes.

Bouldnor is the only site where there is a more-or-less complete succession of the Bouldnor Formation and the only place where the Hamstead Member is exposed. These are the youngest strata of the local Palaeogene sequence and the site is one of the best localities for the study of low-energy, brackish and freshwater clastic depositional environments along with its diverse fossil biota. In addition to the fossil arthropod importance of this site, the area is also selected for the GCR for the Tertiary Palaeobotany, Palaeogene, Ayes, Tertiary Mammalia and Tertiary Reptilia selection categories.

## Description

The whole succession of the Bouldnor Formation extends from Bouldnor Cliff and its north-easterly continuation in Hamstead Cliff for about 3.2 km to Hamstead Ledge. In recent decades there has been considerable slippage of the fine-grained and relatively unconsolidated sediments resulting in cliff collapse and destruction of the lithological succession and other parts of the outcrop are overgrown resulting in intermittent exposures (Figure 5.29). The section comprises a complete sequence of the Bouldnor Formation (almost 110 m thick, see (Figure 5.30)) and mostly consists of muds and silts with a variable fossil content. The sedimentary succession has been subdivided into three units: the Bembridge Marls Member (21.5 m), the Hamstead Member (about 78 m) and the Cranmore Member (about 9.2 in).

Early 19th century descriptions of the cliff section are still the most comprehensive since there was considerably less slippage and deterioration of the cliffs in those days. Recently, the importance of the section has been reviewed by Daley (1999) and there has been palaeontological work on the vertebrates, especially the mammal remains (Hooker 1992), macroinvertebrates by Daley (1972), the microinvertebrate ostracods by Keen (1977), and forams by Murray and Wright (1974). Palaeobotanically, there have been microfloral studies on pollen and spores (Costa and Downie, 1976) and dinoflagellates (Liengjaren *et al.,* 1980), whereas plant fossils described by Chandler (1963) came from two levels within the Hamstead Member, one known as the 'White Band' and the other as the 'Waterlily Bed'. Collinson has detailed the stratigraphical distribution of plant remains within the underlying Bembridge Marls Member (1983).

### Lithology and succession

The Bouldnor Formation is predominantly comprised of black, grey and green muds and muddy silts with varying fossil content. There are two discrete lignitic horizons: the 'Black Band', which marks the base of the Hamstead Member (Figure 5.29), is a carbonaceous mud with freshwater molluscs (e.g. *Unio* and *Viviparus*) and rootlets that penetrate the underlying bed. The *Nematura* Bed is another black lignitic clay, but contains a distinctive brackish-water gastropod fauna. Above the *Nematura* Bed there is a 10.8 m-thick green clay that contains the ironstone band from which the insect fauna has been recovered near the White Band.

Until recently, there was no known lithological representative of the 'Insect Limestone' in this section. Now a nodular representation has been found as seen at Hamstead Ledge. Elsewhere the 'Insect Limestone' occurs close to the base of the Bembridge Marls. The foreshore and cliffs between Hamstead Ledge and Bouldnor were defined by Insole and Daley (1985) as the type area both for the Bouldnor Formation and the Hamstead Member.

## Interpretation

### Sedimentology

Detailed sedimentological work has only been undertaken for the Bembridge Marls Member (Daley and Edwards, 1974). However, a similar lithological succession in the Hamstead Member suggests similar environmental conditions with quiet-water conditions. The generally fine-grained sediment reflects a very low-lying hinterland with a lack of tectonism or rejuvenation of landscapes. Varve-like layering indicates vertical sedimentation perhaps associated with tidal activity but with occasional interruptions of higher energy flow reflected by the introduction of laterally continuous shell coquinas, some of which might result from storm deposition.

The association of these sediments with brackish and freshwater faunas suggests the presence of brackish and freshwater lagoons (Figure 5.30), the upper reaches of which were sufficiently riverine and isolated from the sea to have experienced freshwater conditions. The 'Black Band' with rootlets which marks the base of the Hamstead Member is indicative of very shallow waters and possible short-lived subaeri-al conditions. Similarly, some red-mottled horizons within the member may have originated from contemporary exposure and weathering or a drop in the water table.

### Palaeontology

The site is particularly important palaeontologically because nowhere else in Britain are rocks of this age and facies exposed and thus they provide an unique opportunity for the palaeoecological study of a variety of animal and plant communities from brackish to freshwater environments of Palaeogene age.

The insects from the ironstone band are small but well-preserved remains and include beetles, true flies and an ant (Figure 5.31). Of these groups, the beetles include a weevil (curculionoid); the flies include a crane-fly (limoniine) and owl-midge (psychodid) resembling species from the Bembridge Marls whereas there is also a dance-fly (empidid) which resembles extant *Ocydromia* and *Leptopeza;* the flying ant is referable to the species *Leucotaphus permancus* also known from the Bembridge Marls but species of *Oecophylla* are conspicuous in their absence; finally, an undetermined true bug (heterop-teran) was recognized as part of the fauna in 1998.

Of the associated biota, many of the larger vertebrate fossils are found on the foreshore, having been washed out of the sediment, consequently their exact origin within the stratigraphical succession is not known. Remains of fish, frogs, crocodiles (one of which, *Diplocynodon* was up to 4m long and the genus has been reported from elsewhere in Europe and the USA: Benton and Spencer, 1995), turtles, snakes, lizards, birds and mammals have been found indicating the proximity of land and nearshore conditions. Many of these fossils, especially the reptiles, birds (Harrison and Walker, 1979) and mammals are of international importance because of the rarity of Oligocene terrestrial faunas. The mammal remains have been reported from thin bands of clay within the Hamstead Member (Bosma, 1974) and washed out onto the foreshore. It is a diverse fauna with seven species of rodent, and the same number of artiodactyls, four marsupial species, three insectivores, a pantothere, creodont, primate and rhinoceratid perissodactyl. The larger mammals are also known from the Paris Basin and from where they were originally described. The birds include a mixture of shore birds (ducks and pelicaniforms) and terrestrials such as game-birds, falcaniforms and a flightless ratite.

Of the microfauna, the forams are mainly indicative of hypersaline conditions although some species may indicate open marine conditions marking the deposition of the *Cerithium* Beds and the top of the Hamstead Member.

The microflora also shows a marked change at the same boundary with a decrease in pollen and spore species characteristic of a subtropical climate (e.g. the palm *Thrinax*) and an increase of northern temperate species. A more-detailed study of the dinoflagellate succession suggested to Liengjaren *et al.* (1980) that there have been three transgressive events — one associated with the 'Bembridge Oyster Bed', another with the *Nematura* 'Bed' in the Hamstead Member and a third associated with the Cranmore Member.

The Hamstead Member macroplant remains consist predominantly of the leafy shoots, cones and logs of angiosperms (18 species) and a few conifers (four species) and are typically preserved as carbonaceous films sometimes covered with a thin layer of pyrites. The angiosperm flora is dominated by aquatic plants, especially members of the water soldier, water lily and pondweed families. Although many species are also found lower down in the formation, there are some significant differences that have been associated with climate change (Cleal *et al.,* 2001). Cleal *et al.* have summarized the vegetation and environment of the Hamstead Member as a bulrush-dominated marsh with a range of other aquatic plants and surrounded by forests dominated by taxodiaceous conifers somewhat similar to that of today's cypress swamps in south-eastern USA.

### Palaeoclimate

Machin's (1971) work on the microflora revealed a climatic shift away from tropical/warm temperate climates during earlier post-Bartonian times to cooler conditions. This is complemented by Buchardt's (1978) oxygen isotope temperature data derived from Palaeogene shell material which shows a sharp drop in palaeotemperature at the beginning of the Oligocene. Furthermore this cooling is supported by Collinson and Hooker's (1987) analysis of the plant record and conclusion that by the beginning of the Oligocene (Rupelian times), the dense forests of tropical aspect had given way to a more open environment with scattered trees. The Hamstead mammals also show a decrease in arborescent forms and increase in larger ground-dwelling mammals, especially browsing herbivores with a high fibre diet. Their presence reinforces the view that there was an open, moderately wooded woodland–brushland environment (Benton *et al.,* 2005.

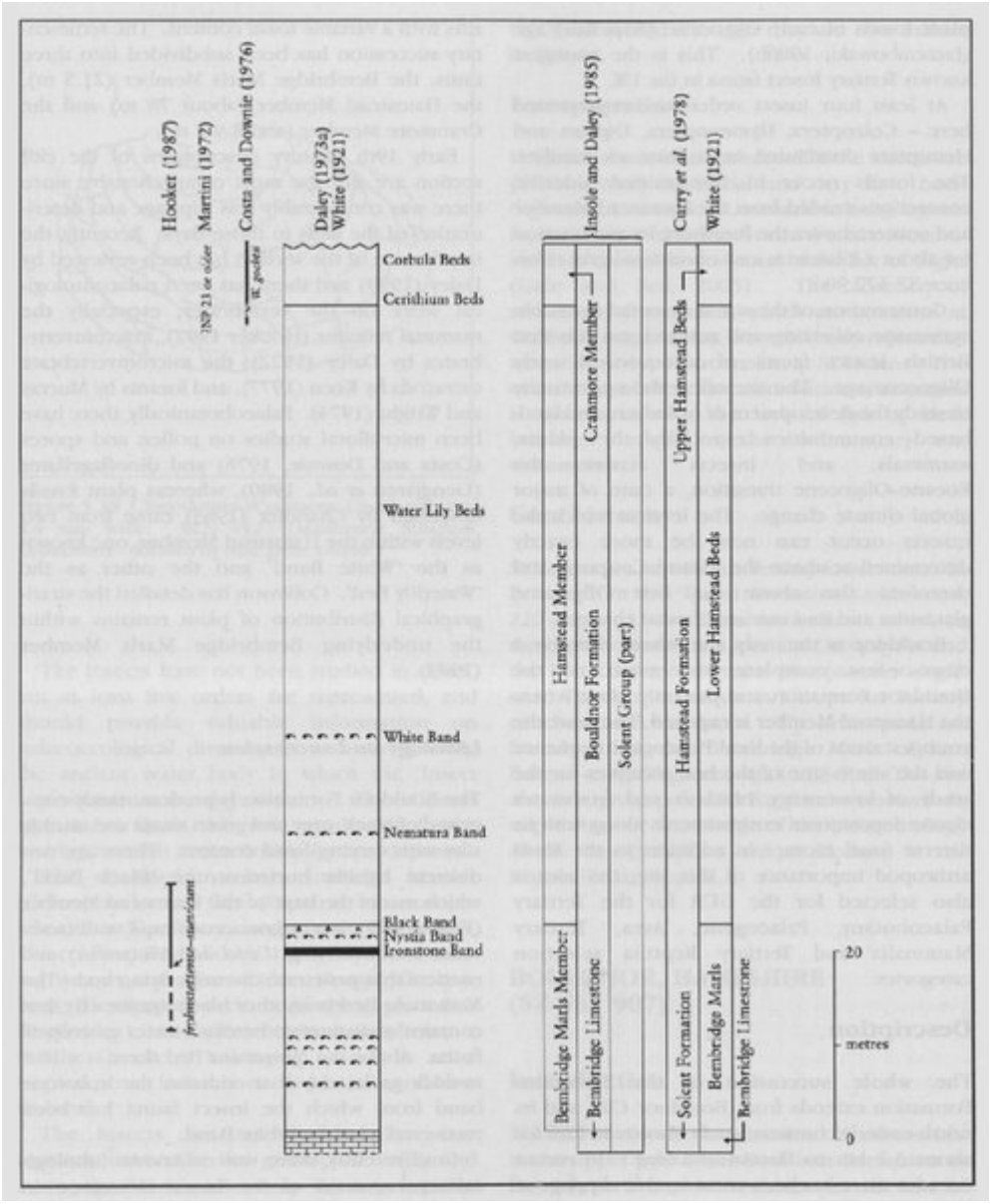
### Dating and correlation

The palaeontology of this site is important in providing correlation of British Oligocene strata with other areas of north-western Europe (see Daley and Balson, 1999 for discussion). Furthermore, the site was selected by Curry and Hailwood (1986) as typifying the English succession across the Eocene/Oligocene boundary. The famous Quercy deposits of France also span this boundary and similarly have produced a fossil biota including lizards, crocodilians and turtles. However, there have been some problems associated with the exact location of the boundary within the Bouldnor Formation. Liengjaren *et al.* (1980) have suggested that it could be taken at the bottom of the Hamstead Member, some 9m below the *Nematura* Band. However, Hooker (1992) claims that the boundary lies at a greater distance below the band and that the mammals are typical of the post 'Grand Coupure' faunal change at the Eocene–Oligocene boundary.

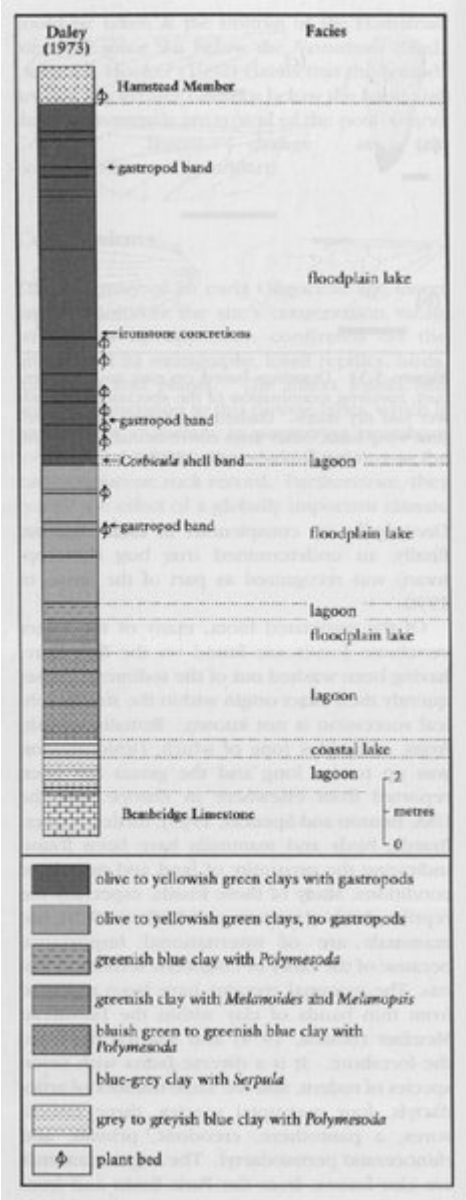
## Conclusions

The discovery of an early Oligocene age insect fauna re-inforces the site's conservation value, which has already been confirmed on the grounds of its stratigraphy, fossil reptiles, birds, mammals and plants. The insect fossils add another dimension to this diverse biota, which is particularly important in preserving nearshore to terrestrial environments, which are rare in the early Oligocene rock record. Furthermore, they record the effect of a globally important climate cooling event.

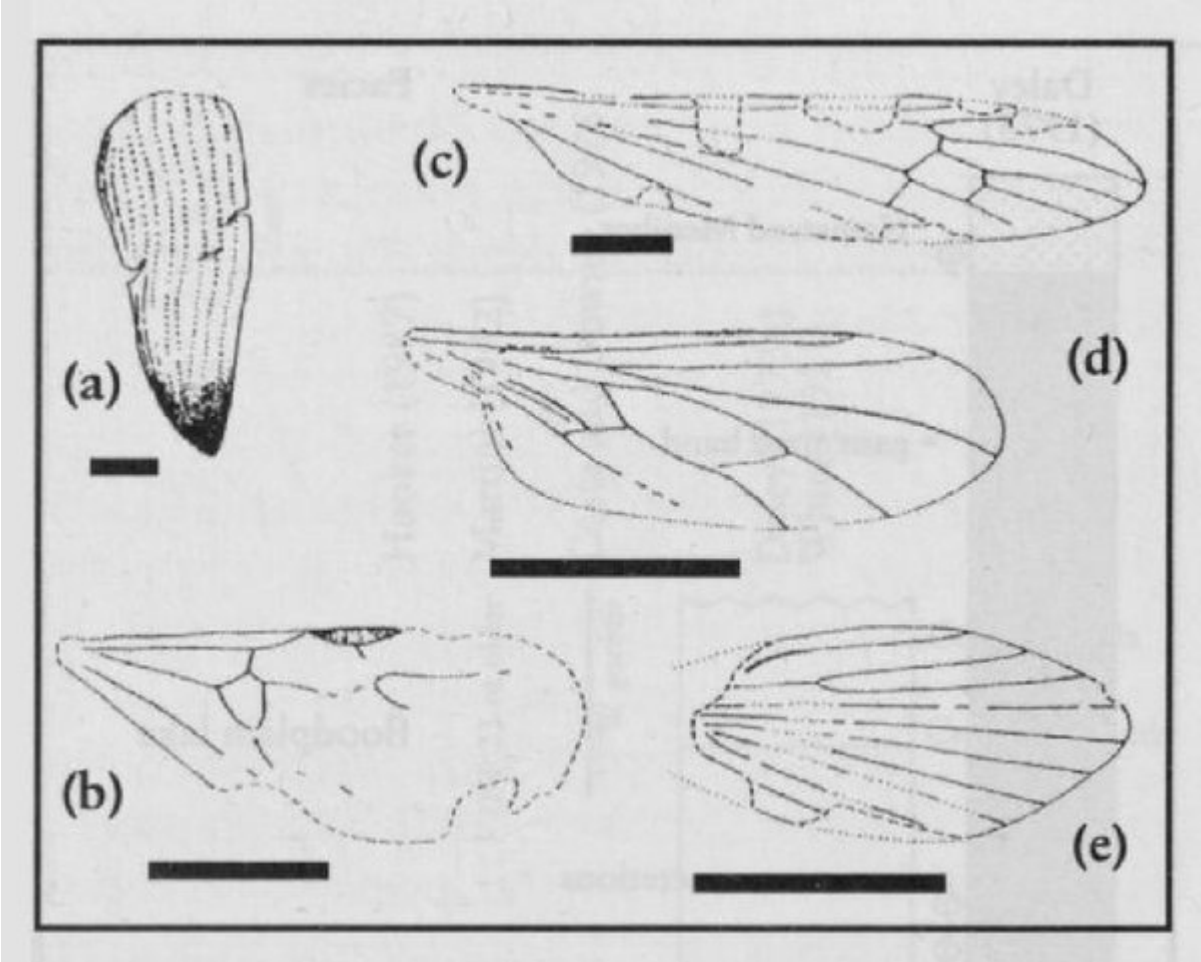
**References**




*(Figure 5.29) Lithostratigraphical succession of the Bouldnor Formation in Bouldnor and Hamstead cliffs, Isle of Wight as interpreted by the authors indicated. (From Cleal el al., 2001.)*




*(Figure 5.30) Stratigraphical section through the Bembridge Marls Member and Bouldnor Formation at Hamstead Ledge. (After Collinson, 1983; from Cleal et al, 2001.)*




*(Figure 5.31) Drawings based on part and counterpart, involvng examination of the specimens in both wet and dry states. Dashed-and-dotted lines represent wing folds, other lines conventional. Scale line is 1 mm. (After Jarzembowski, 1980b.)*