Bognor Regis, West Sussex

[SZ 934 987]–[SZ 889 970]

Potential GCR site

Highlights

As the most easterly exposure of London Clay in the Hampshire Basin, Bognor has both a stratigraphical and palaeoenvironmental importance. Its value is increased by the presence of a rich and varied fossil fauna and flora and by the fossils being particularly well preserved in the unweathered foreshore sections.

Introduction

Although formally referred to here as Bognor Regis, the site comprises intermittent foreshore exposures from Bognor [SZ 934 987] westwards to Aldwick and Pagham [SZ 889 970]. The deposits present comprise silty muds and sands of the lower to middle part of the London Clay which dip at a low angle to the south-west. Two sandstone 'reefs' form local landmarks: the Bognor Rocks [SZ 922 982] and, further west at Pagham, the Barn Rocks [SZ 907 978].

Early, but somewhat limited descriptions, include those of Dixon (1850), Dixon and Jones (1878) and Reid (1897), who paid particular attention to the Bognor Rocks. In the 20th century, sustained research by Venables (see Bone, 1992a,b) led to a considerable understanding of the stratigraphical succession. Early work by Venables (1929), the first detailed account of the stratigraphy, was ultimately followed by a more comprehensive study (Venables, 1963) in which he divided the succession into 'Groups', which in turn were partially subdivided into beds. Subsequently, further horizons were recorded by Bone (1978) and the stratigraphy redescribed by King (1981, pp. 71–3).

Whilst early workers such as Dixon (1850) dealt with a range of fossils, the palaeontological importance of the section has been emphasized by more recent specialist studies. These include work on the almost unique insect fauna by Britton (1960), Venables and Taylor (1963) and Jarzembowski (1993), on plant macrofossils by Chandler (1961b, 1964, 1978) and Collinson (1983a), on fish teeth by Casier (1966), fish otoliths by Stinton (1957, 1975, 1975, 1978, 1980), and crinoids and ophiuroids by Rasmussen (1972). The molluscan fauna has attracted attention over many years and has recently been reviewed by Tracey (1992). The nautilid fauna has been considered by Hewitt (1988a,b). Venables' 1963 paper included work on the microfauna (foraminifera and ostracods) from Bognor.

This account of the Bognor site draws upon an earlier unpublished description compiled by Bone in 1985 (pers. comm.).

This site was also independently selected for its fossil plant, fish and bird content, a more detailed account of which can be found elsewhere in the GCR series (*Mesozoic to Tertiary Palaeobotany of Great Britain* (Cleal and Thomas, in prep.); *Fossil Fishes of Great Britain* (Dineley and Metcalf, 1999); *Fossil Mammals and Birds of Great Britain* (Benton *et al.,* in prep.). This site was also selected for its fossil insect content, details of which will be discussed in a future GCR volume.

Description

The foreshore section at the Bognor site comprises a sequence of silty muds and sands dipping gently west-south-west. King (1981) identified his informal divisions A, B and C of the London Clay, together with 3+ m of his Oldhaven Formation identified by augering at the eastern end of the section.

The junction with the Reading Formation is hidden by river alluvium, whilst extensive beach sediments obscure the higher part of the sequence between Barn Rocks and Pagham Harbour, with the junction of the London Clay and Bracklesham Group unexposed.

Lithological succession

King's (1981) description of the section refers to the presence of almost 90 m of London Clay, representing strata from low in his division A (*c.* 43 m), division B (*c.* 33 m) to the middle of division C (12+ m) (King, 1981, pp. 71–3), whilst conceding the difficulty of measuring the section with any degree of accuracy. The succession (Figure 6.21) mainly comprises muds (silty clays, clayey silts), but at two horizons, glauconitic sands are present. These are partially lithified and comprise the Bognor Rock Bed (Bognor Member of King, 1981) and the younger Barn Rock Bed.

Lithostratigraphy

In the succession at Bognor, King's division A1 is apparently absent, the lowest part of this division present being A2, the Walton Member. The remainder of the division (A3) comprises a coarsening-upwards sequence, terminating in the glauconitic sands of the 'Bognor Rock Bed' of earlier authors. This is the Bognor Member of King (1981, p. 26) for which the Bognor Regis foreshore [SZ 922 982] is the stratotype (see also Edwards and Freshney, 1987b, p. 50). The unit both here and elsewhere is partially cemented to form large nodules of calcareous sandstone. Division B of King (1981) has a base marked by rolled black flint pebbles in a sandy mud, but overall forms a second coarsening-upwards sequence which terminates in the partially cemented, fine glauconitic sandstone of the 'Barn Rock Bed'. Division C is seldom exposed, but is considered to have a basal glauconitic pebble bed (King, 1981, p. 73).

Palaeontology

Just west of Bognor pier, division A commences with the muds of the 'Astarte Bed' and the appearance of a rich and well-preserved calcareous macrofauna, including the bivalve *Astarte subrugata.* Above a distinctive septarian band, the 'Starfish Bed' contains a similar fauna and the remains of the brittle star *Ophiura bognoriensis* described by Rasmussen (1972). Above, the 'Cyprina Bed' contains little more than fragments of *Arctica* ('*Cyprina*') *planata,* whilst the succeeding 'sandy clay' of Venables (1929, 1963) contains *Ostrea tabulata, Pinna affinis, Panopea intermedia* and *Ditrupa plan.* The Bognor Member has a distinctive macrofauna of large bivalves and gastropods including *Glycymeris brevirostris* and *Athleta denudatus* together with the annelid *Rotularia bognoriensis.*

King (1981, p. 73) refers to the varied fauna and flora of division B. Much of B1 comprises silty clays characterized by an abundant microfauna containing elements of the 'Nodosariid-rich' fauna of the London Basin. Wright's (1972) 'planktonic foraminiferid datum' occurs near the base, shortly above the 'Lower Fish Tooth Bed'.

Pyrite occurs abundantly, ranging in size from small grains to nodules, together with a variety of pyritized fossils. Amongst these are pyritized beetles (Britton, 1960; Venables and Taylor, 1963). Britton (1960) recognized 58 different fossil insects from Bognor. No insects have been found *in situ* but, along with a large assemblage of land-derived seeds and fruits, fish teeth, bones and otoliths, occur as foreshore concentrates on the outcrops of B1 and the lower part of B2 (King, 1981, p. 73). Most insects come from the 'Beetle Bed' of Venables (1963).

Septarian nodules are common, mainly as distinct layers, which can form useful marker horizons. Scattered phosphatic nodules are also common, often containing crustacean, turtle and fish remains or nautiloids. Driftwood often occurs, frequently as large logs and usually well-bored by *Teredo.* In a recent study of pyritized twigs from the London Clay, Poole (1992) found division B at Bognor to be a good source of material albeit, like the other pyritic fossils, predominantly secondarily derived from present-day beach concentrates.

Within the relatively unfossiliferous muds higher up the B2 sequence, *Arctica* and *Pitar* are the most common macrofossils. *Cainocrinus tintinnabulum* (see Rasmussen, 1972) occurs at one horizon where abundant current-drifted crinoid, otolith and shell debris accumulated against fossil logs (Bone, 1978). At the top of B2, the 'Barn Rock Bed' contains sporadic and poorly preserved fossils, of which the most common is *Cultellus affinis* (D.A. Bone, 1985, pers. comm.).

In the rarely exposed division C, two horizons with common macrofossils, the 'Pholadomya Bed' and the 'Cainocrinus Bed', are occasionally exposed 9–12 m above the base.

Recently, Tracey (1992) has reviewed the Bognor molluscan fauna. He listed 141 species: 75 gastropods, 65 bivalves and one scaphopod. Cephalopod material is mentioned although not identified in more detail. Hewitt (1988a,b), however, referred to four nautilid genera from division B, including museum and other material found by earlier workers. These are *Cimomia, Deltoidonautilus, Euciphoceras* and *Simplioceras.*

Interpretation and evaluation

The Bognor section is one of the few coastal exposures of the London Clay in the Hampshire Basin and as the most easterly exposure of the London Clay in this area, it is significant both stratigraphically and palaeoenvironmentally. The value of the site is enhanced by wide outcrops of the constituent beds produced by the shallow dip (contrasting with the narrow exposures in the near-vertical strata of Whitecliff and Alum Bays) and this has provided an unusually good opportunity for the collection and study of faunal and floral remains.

Comparison with other localities

Compared with the London Clay in Whitecliff Bay and Alum Bay, the Bognor section is about two-thirds complete and becomes obscured towards the top of the succession. Unlike these other two localities, however, it is unweathered and in consequence, both fauna and flora are well preserved.

Lack of exposure at the western end of the section inhibits comparison above the lower part of division C, but below the latter, the succession is broadly similar to that of Whitecliff Bay. Division Al is absent at both localities, whereas A3 is thicker at Bognor and thins markedly westwards (see King, 1981, text-fig. 36). The Bognor Member is better represented here than in Whitecliff Bay and is absent further west in the Southampton area (Edwards and Freshney, 1987a, fig. 12). Division B is less thick at Bognor than at Whitecliff Bay (where it measures 39.8 m according to King, 1981, p. 77) but is stratigraphically important since the lower part of division B at the latter locality is always badly slipped and poorly exposed.

Invertebrate palaeontology

The diverse nature of the molluscan fauna has become apparent over the years: 57 species recorded by J. de C. Sowerby (in Dixon, 1850) have, with time, increased to 62 (Venables, 1929), 128 (Venables, 1963) and presently number just in excess of 140 (Tracey, 1992). Tracey referred particularly to the well-preserved molluscs in the lowest part of division A3 (the Astarte, Starfish and Cyprina Beds) and the mainly pyritized molluscs of the Beetle Bed and Upper Fish-tooth Bed of division B.

The fossil assemblages of division B are particularly important since Bognor is the only location in the Hampshire Basin to yield material at this level in any quantity. The Beetle Bed is especially valuable since it contains the only significant insect fauna from the London Clay. Furthermore, Bognor remains the principal international source of pyritized insects Uarzembowski, 1992, p. 93).

By comparison with the ecology of present-day relatives, the insect fauna is predominantly one of Mediterranean-subtropical woodland (Britton, 1960). Following the assertion of Rundle and Cooper (1971) that insects from the London Clay drifted out to sea with wood, Jarzembowski (1992) has suggested that the more westerly, near-shore location of the Hampshire Basin accounts for the fact that London Clay insects are mainly from this area. This is further supported by the presence of flightless larvae, together with beetles with their wing cases in the rest position.

Work by Hewitt (1988a,b) on the nautilids has shown that these can be valuable palaeoenvironmental and, particularly, depth indicators. He considered that life assemblages of *Euciphoceras* and *Simplicioceras* probably extended to a depth of around 130 m, with *Cimonia* and *Deltoidonautilus* added to the fauna at depths of less than 70 m. Whilst referring to the Bognor section as 'near shore', Hewitt (1988b) pointed out that depths can be inferred from implosion studies of transported shells and that these have raised estimates of water depth.

Plant fossils

The Bognor flora is considerably older than that of Sheppey, and is the main source of plant material in division B of the London Clay (see Collinson, 1983a, pp.6–7). It therefore provides a useful source of data for both palaeoclimatic and palaeoenvironmental interpretation at this stratigraphical level. Of the London Clay flora as a whole, the majority of really small fossils and seeds come from Bognor (Chandler, 1978). However, whilst about 40 species of fossil plants come only from the London Clay of Bognor, both Chandler (1964) and Collinson (1983a) considered the London Clay Flora as a whole as relatively uniform, with the differences from one locality to another reflecting the vagaries of fossilization processes and collecting. Overall, it therefore seems likely that climatic conditions were not dissimilar from those of the rest of London Clay times.

Depositional environment

The coarsening-upwards cycles represented here by King's divisions A and B represent the transgressive/regressive cyclicity characteristic of the London Clay. The glauconitic nature and the palaeontology of the sands at the tops of both units confirms that the regressive elements are fully marine in this area. However, as King (1981) pointed out, some fossil elements are clearly land-derived. Indeed, the association of plant material with insects suggested to Chandler (1964, p. 44) that, in London Clay times, there was closer proximity to land at Bognor than at Sheppey.

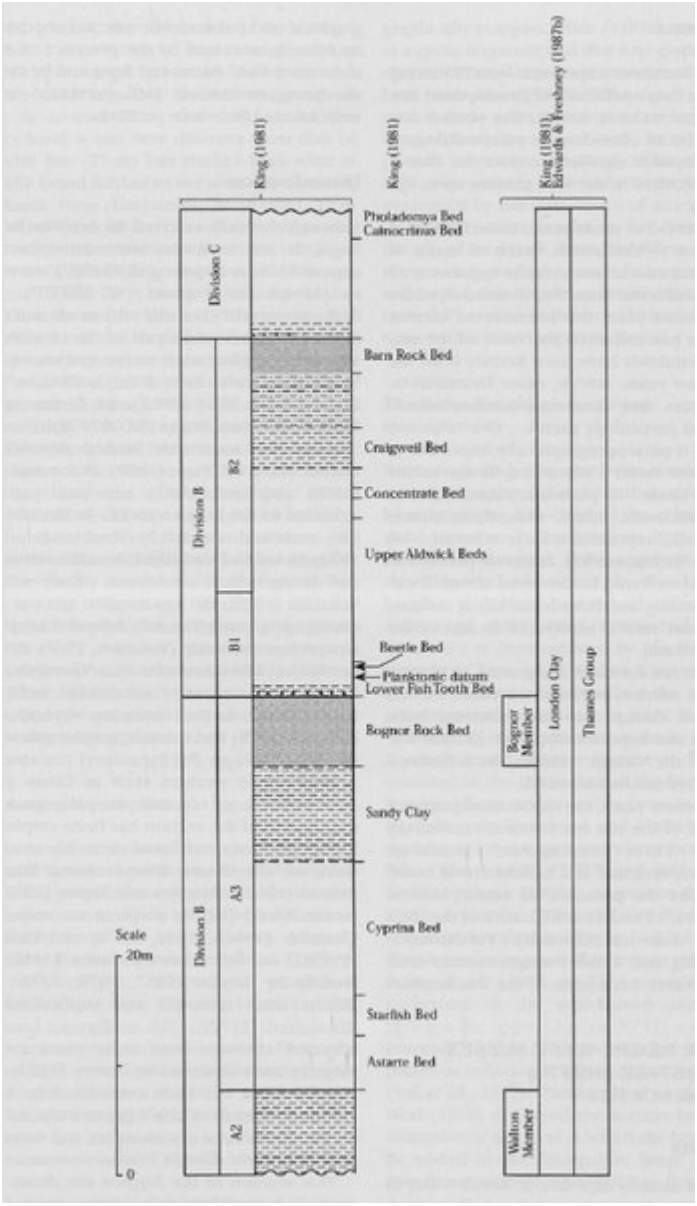
Conclusions

As the furthest east of the natural exposures of the London Clay in the Hampshire Basin, the Bognor site provides an important data source for regional palaeogeographical and palaeoenvironmental interpretation.

A significant feature of the site is that since the foreshore exposures are unweathered, both fauna and flora are generally well preserved. This is particularly important regarding those horizons, such as the lower part of division B, which are elsewhere badly slumped or decalcified.

A wide variety of plant and animal fossils occur. Of these, the pyritized insect fauna is almost unique, with Bognor the principal international source of pyritized insects.

References



(Figure 6.21) London Clay succession at Bognor Regis, West Sussex (after King, 1981, text-fig. 23).