Bognor Regis, West Sussex

[SZ 918 984]

Introduction

Foreshore exposures of the Ypresian London Clay Formation at the coastal resort of Bognor Regis have over several decades provided an abundant and diverse fossil biota, notably of insects. This biota has proven to be of international significance as the most important source of pyritized insects of any age. In addition, these most easterly exposures of the London Clay in the Hampshire Basin have considerable stratigraphical and palaeoenvironmental significance.

The site has also been selected independently as a GCR site on other counts: for its fossil plants (Cleal *et al.*, 2001), fishes (Dineley and Metcalf, 1999), mammals and birds (Benton *et al.*, 2005) and its stratigraphy (Daley and Batson, 1999). In addition to the fossil arthropod importance of this site, the area is also selected for the GCR for the Tertiary Palaeobotany, Mesozoic–Tertiary Fish/Amphibia and Ayes selection categories.

Description

Stratigraphy

The intermittent foreshore exposures between Bognor Regis and Pagham to the west comprise silty muds and sands of the lower to middle part of the London Clay Formation, which dip here at a low angle to the south-west (Figure 5.16). The succession is interrupted by two marker horizons — the stratigraphically lower and older Bognor 'Rocks' and the higher and younger Barn 'Rocks' at Pagham (see (Figure 5.17)). Early research in the 19th century focused largely on the Bognor Rocks (see, for example, Dixon, 1850; Reid, 1897). From the late 1920s, the modern phase of detailed investigation was initiated by a local collector Edmond Martin Venables (1901–1990). Over a period of nearly 40 years, Venables developed the first detailed stratigraphy and careful collection of the fossil biota (see Bone, 2003). Because of intermittent tidal exposure and the low concentration of Insects, it was Venables' long-term collecting that allowed so much information to be recovered from this site.

Venables (1929, 1963) recorded some 90 m of London Clay exposed along the foreshore and divided the succession into 'Groups' which in turn were partially subdivided into 'Beds'. More recently, the succession has been further elaborated by Bone (1978) and King (1981). The latter identified a general informal division of the London Clay into A, B and C divisions with an estimated total thickness of 90 m. The succession is comprised mostly of partially consolidated mudrocks (silty clays and clayey silts) but there are also two horizons of more lithified glauconitic sands known as the 'Bognor Rock Bed' and the 'Barn Rock Bed'.

The exposure of the succession at Bognor varies depending upon winter storm activity and the relative local removal and or deposition of sand. Most of the sequence is only accessible at low tide. The lowest part of King's London Clay succession (Subdivision Al of Division A) is apparently absent with the lowest strata belonging to Subdivision A2, the Walton Member (Figure 5.18). Above this, the remaining 30 or more metres of subdivision A3 comprise a coarsening upwards sequence of sandy clay and finally the glauconitic sandstones of the Bognor Rock Bed (Bognor Member) for which this site is the stratotype. The sediments are partly cemented by carbonate to form large nodules of calcareous sandstone.

The base of the succeeding Division B has a base marked by a conglomeratic horizon of rounded black flint pebbles in a sandy mud. However, overall, the succession of Division B forms another coarsening upwards succession which terminates in the second partly cemented calcareous and glauconitic sandstones of the barn Rock Bed. Division C is seldom exposed but is thought to have a base marked by another conglomeratic flint pebble layer, which might thus represent the beginning of a third depositional rhythm.

Palaeontology

Overall, much of the London Clay Formation is fossiliferous with a diverse biota, both terrestrial and marine, of plants, invertebrates (macro- and micro-invertebrates) and vertebrates. Most abundant in species terms are molluscs (altogether some 141 species, of which 75 are gastropods, 65 bivalves and one scaphopod known so far) and plants (some 130 species, mostly angiosperms, forming the most diverse early Eocene fruit and seed flora in Britain). The Bognor flora, mostly from Division B, is important as the main source of information about plants from this level within the London Clay Formation (the Isle of Sheppey outcrop being younger).

However, vertebrates are also common, especially fish, but also a few birds (six species) have been found. The fish records include some 47 species, mostly comprised of the teeth of cartilagenous chondrichthyans, but also the bones and otoliths of some 12 teleosts. The abundance of predatory fish indicates that local waters were highly productive. However, the distribution of individual groups within the overall biota is very variable with particular assemblages being dominant at specific horizons. Historically these have been identified by the name of one especially common or obvious kind of fossil, for example the Astarte bed (at the base of subdivision A3), named after the bivalve *Astarte subrugata,* which is abundant within this horizon.

Most important in the present context is the faunal succession at the base of Subdivision B1 above the Bognor Member. Much of the B1 silty clays are characterized by an abundant microfauna containing elements of the nodosariid-rich (planktonic foraminiferid) datum of the London Basin. The sediment is enriched with secondary pyrite ranging from small grains to nodules and a common pyritization of the fossil fauna.

The insects

Of especial interest here are the remains of numerous pyritized beetles (Coleoptera) and a hemipteran, mostly adult stages (imagines) all of which appear to be stratigraphically restricted to the London Clay Formation (Figure 5.19). They are accompanied by pyritized seeds and fruits as well as fish and mollusc remains.

Britton recognized 58 different fossil insects from among 231 specimens obtained from this horizon at Bognor by Venables (1929, 1962 and Venables and Taylor, 1963), but only seven species have been formally named (see Jarzembowski, 1992, appendix 1, p.94) and none of them have been found in *situ;* more taxonomic work is required on this important entomofauna. Typically, the insects occur as foreshore concentrations of loose specimens washed out of the parent sediment by wave action and winnowed by wave swash and backwash and left stranded on the beach. The fossils are typically small (less than 7 mm long) and very rare. Venables and Taylor (1963) estimated that each foreshore find represents the erosion of at least a tonne of sediment and hand picking from within a third of a litre of fine-grained pyrite. Although no insects have been found *in situ,* Venables' careful mapping of his finds indicated that they are almost all derived from a single horizon — the so-called 'Beetle Bed' (Figure 5.16) and (Figure 5.17).

Weevils are the most common fossil insects here (Figure 5.19)a,d. This fact may partly reflect that their family (the Curculionidae) is very diverse and is in fact the most diverse extant family in the animal kingdom with some 57 000 described species belonging to 6000 genera. The woodworm family (Anobiidae) is second most common at Bognor ((Figure 5.19)b,c), but much less so than the weevils, and there are also significant numbers of elateroid beetles (click-beetle like families Throscidae and Eucnemidae). One of the elateroids — *Pactopus avitus* Britton — is biogeographically significant as a rare living species known only from western North America. This distribution suggests that modem *Pactopus is* a relict form in North America Oarzembowski, 1992). The oldest known eucnemid, *Potergite senectus* has also been found at Bognor. In addition, there are occasional shield bugs (Pentatomidae) and members of the Scarabaeidae. Although this latter family are best known as scarabs, their fossil representatives at Bognor are not typical. For example they include a species of *Saprosites* which is an extant genus of wood-boring beetle. Another genus, *Onthophagus,* does however include extant species associated with dung.

The Beetle Bed is especially valuable since it contains the only significant insect fauna from the London Clay Formation and provides the main international source of pyritized insects. The terrestrial insects represent a Mediterranean-subtropical woodland environment (Britton, 1960) probably derived from the nearby Hampshire Basin

margin.

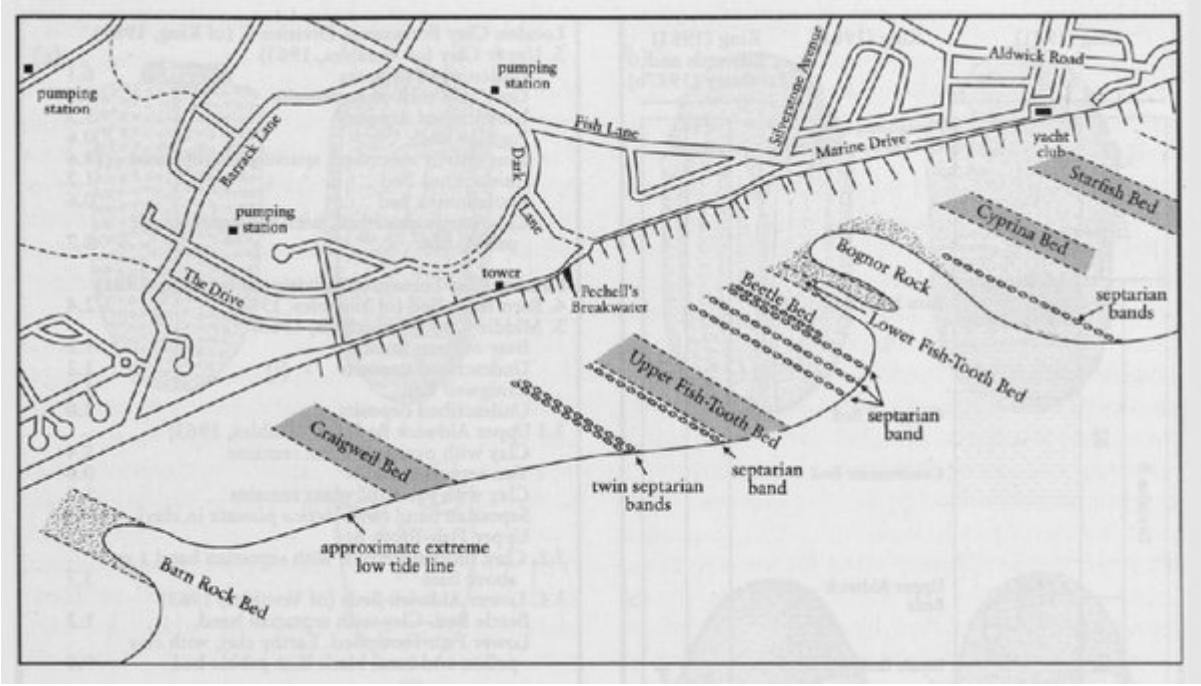
Interpretation

The repeated sedimentary regressive rhythms are typical of the London Clay Formation in general with the presence of glauconite and faunal elements such as the nautiloids and starfish showing that the regressive units were fully marine in this area with the land-derived plant and insect fossils being introduced by offshore currents from a nearby landmass. The presence of beetles with their wing cases in the rest position suggests that they were perhaps carried out to sea on driftwood. The low diversity of the insect fauna at the ordinal level (but with a high species diversity) supports the evidence that they mostly drifted into the original depositional area as flotsam. Water depths of less than 70 m have been postulated by Hewitt (1988) on the study of nautiloid fossils. Comparison of the Bognor fossil flora with that of the slightly younger succession on the Isle of Sheppey shows that climatic conditions did not vary greatly throughout the time of London Clay deposition.

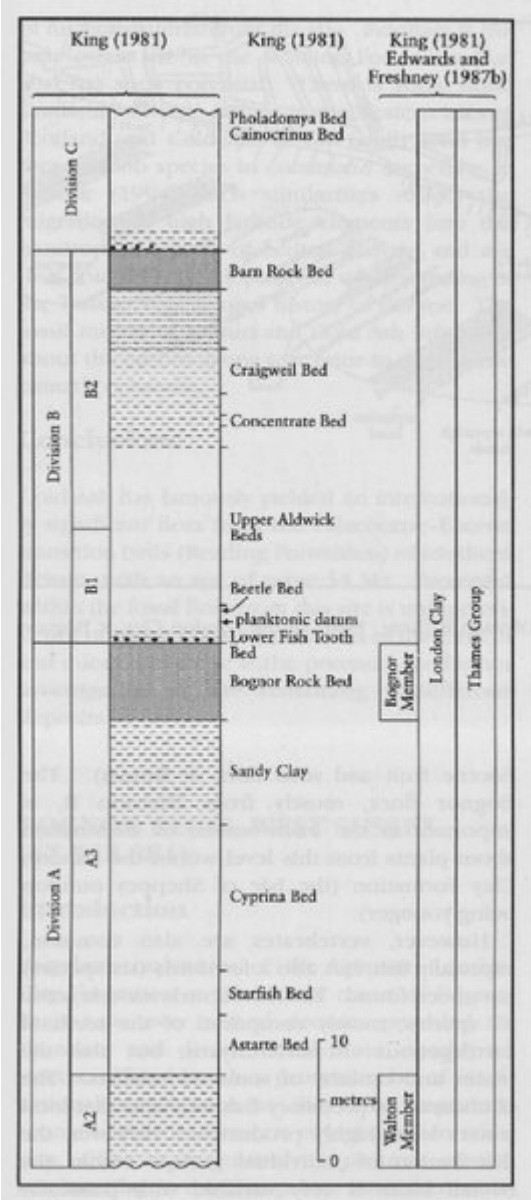
Conclusions

The foreshore exposures of the London Clay at Bognor Regis provide one of the few coastal exposures of the London Clay Formation in the Hampshire Basin and the most easterly in this region. The fossil insects found here, especially the pyritized beetles, are of international importance. Analysis of the entomofauna, the accompanying diverse biota and sediments provides important evidence for regional palaeogeographical and palaeoenvironmental interpretation. The site also has considerable potential for future finds with the shallow dip of the strata producing wide outcrops and an unusually good opportunity for the collection and study of the fossil biota.

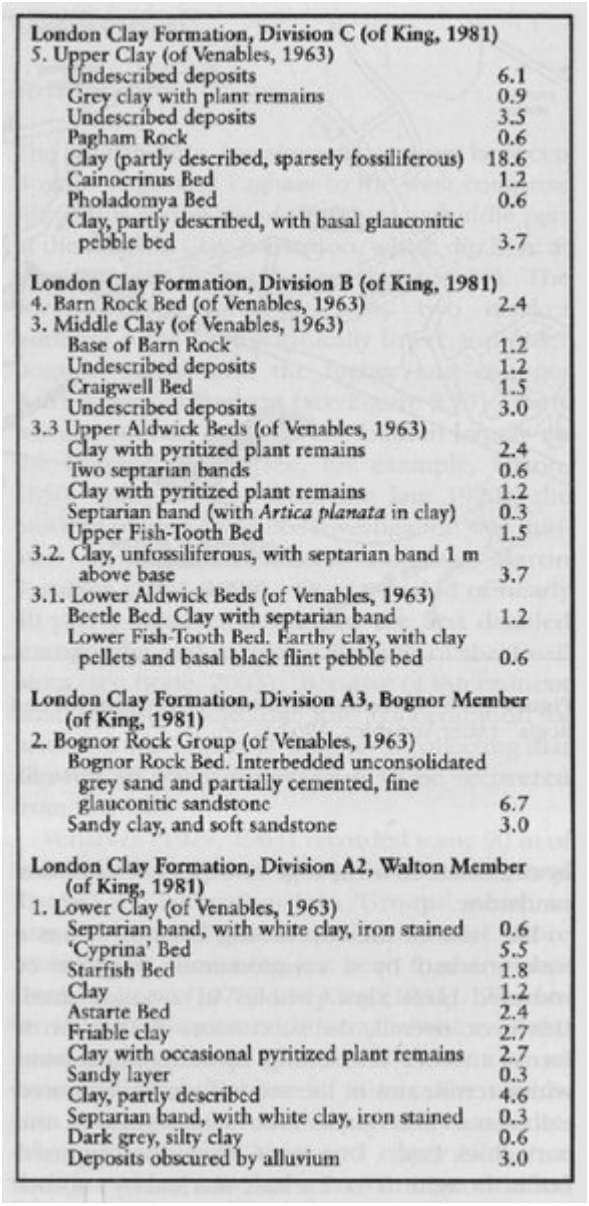
References



(Figure 5.16) Foreshore exposure of Division A3 and Division B (King, 1981) of the London Clay at Bognor Regis. (After Venables, 1962.)

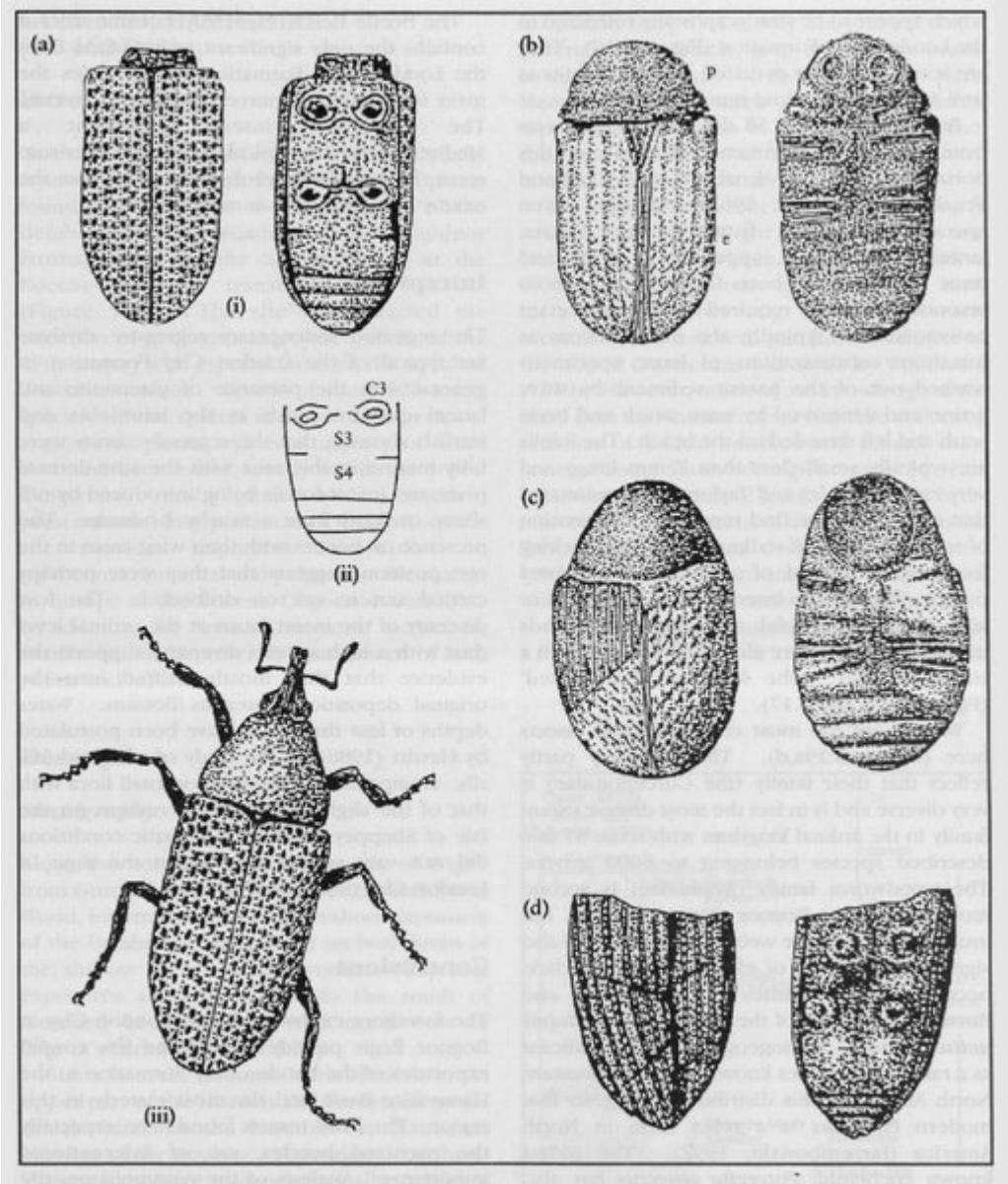


(Figure 5.17) London Clay succession at Bognor Regis, West Sussex. (After King, 1981.)



London Clay Formation, Division C (of King, 1981)	
5. Upper Clay (of Venables, 1963)	
Undescribed deposits	6.1
Grey clay with plant remains	0.9
Undescribed deposits	3.5
Pagham Rock	0.6
Clay (partly described, sparsely fossiliferous)	18.6
Cainocrinus Bed	1.2
Pholadomya Bed	0.6
Clay, partly described, with basal glauconitic pebble bed	3.7
London Clay Formation, Division B (of King, 1981)	
4. Barn Rock Bed (of Venables, 1963)	2.4
3. Middle Clay (of Venables, 1963)	
Base of Barn Rock	1.2
Undescribed deposits	1.2
Craigwell Bed	1.5
Undescribed deposits	3.0
3.3 Upper Aldwick Beds (of Venables, 1963)	
Clay with pyritized plant remains	2.4
Two septarian bands	0.6
Clay with pyritized plant remains	1.2
Septarian band (with *Artica planata* in clay)	0.3
Upper Fish-Tooth Bed	1.5
3.2. Clay, unfossiliferous, with septarian band 1 m above base	3.7
3.1. Lower Aldwick Beds (of Venables, 1963)	
Beetle Bed. Clay with septarian band	1.2
Lower Fish-Tooth Bed. Earthy clay, with clay pellets and basal black flint pebble bed	0.6
London Clay Formation, Division A3, Bognor Member (of King, 1981)	
2. Bognor Rock Group (of Venables, 1963)	
Bognor Rock Bed. Interbedded unconsolidated grey sand and partially cemented, fine glauconitic sandstone	6.7
Sandy clay, and soft sandstone	3.0
London Clay Formation, Division A2, Walton Member (of King, 1981)	
1. Lower Clay (of Venables, 1963)	
Septarian band, with white clay, iron stained	0.6
'Cyprina' Bed	5.5
Starfish Bed	1.8
Clay	1.2
Astarte Bed	2.4
Friable clay	2.7
Clay with occasional pyritized plant remains	2.7
Sandy layer	0.3
Clay, partly described	4.6
Septarian band, with white clay, iron stained	0.3
Dark grey, silty clay	0.6
Deposits obscured by alluvium	3.0

(Figure 5.18) The succession at Bognor Regis. (From Dineley and Metcalf, 1999).



(Figure 5.19) (a) Pissodites argillosus Britton (Curculionidae: Hylobiinae), Beetle Bed, Bognor Regis, Sussex. (i) Hindbody, dorsal and ventral views, length 3 mm. [Holotype in NHM, In. 493251, hindbody showing diag■ nostic curculionid characters (S3, S4, basal abdominal stemites; C3, hind coxa); (iii) reconstruction. (b)—(d) Coleoptera in Tony and Ben Parker collection, NHM, from the Beetle Bed, Bognor Regis, dorsal and ventral views. (b) Anobiid gen. et. sp. nov., length 2mm, In. 64733; p, pronotum, e, elytron,; (c) Venablesia sp. nov. (Anobiidae). Length 5mm, In. 64732. (d) Curculionid with cuticle preserved, ?In. 64734, (After Venables' work and as figured in Jarzembowski, 1992.)