BOGNOR REGIS

OS Grid Reference: SZ920979–SZ924983

Highlights

A rich fossil fish fauna has been derived from foreshore exposures of the Aldwick Beds (London Clay, Division B) at Bognor Regis in West Sussex. The preservation is excellent and many type specimens of teleost otoliths have been described.

Introduction

The foreshore exposures of London Clay Formation at Bognor Regis have yielded a finely preserved vertebrate fauna, including land-derived mammals and reptiles, and shark and teleost debris, occurring mainly as teeth, scales, otoliths and bones, mostly from three horizons in the 'Aldwick Beds' (Division B of King, 1981). The vertebrate remains can be recovered from the outcrops on the foreshore, or frequently from pyritous debris pools on the shoreline that concentrate the scattered fossil material. Many species of elasmobranch and teleost fishes have been recovered by bulk processing the sediments and beach sands, although in more recent years coastal protection schemes have diminished the exposure.

Much of the early work on the London Clay at Bognor focused upon the palaeontology, and limited descriptions include those of Dixon (1850) and Reid (1897). Venables (1929, 1963) produced the most detailed account of the geology and the succession of beds exposed along the shoreline, and also produced descriptions of the insect fauna recovered from the 'Beetle Bed' (London Clay, Division B; Venables and Taylor, 1963). Subsequent work by King (1981) has focused on the stratigraphy and the site is also designated as an SSSI for Tertiary stratigraphy in the GCR volume by Daley and Balson (1999).

The fish fauna was listed by Venables (1963), and components of it have subsequently been described by Casier (1966); elasmobranchs) and Stinton (1965c, 1971; teleost otoliths).

Description

The London Clay Formation exposed along the coast from Bognor westwards to Aldwick and Pagham comprises intermittent foreshore outcrops of silty muds and sands, which dip at a low angle towards the south-west. The following composite section is taken from the description of the sequence by Venables (1963), with additional information on the formal stratigraphical nomenclature of beds from King (1981):

		Thickness (m)
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

Over 90 m of London Clay is exposed along the Bognor coastline (King, 1981). King (1981) recognized 3 m of the Oldhaven Formation (the London Clay Division A1 being apparently absent; Daley *in* Daley and Balson, 1999) beneath beach sand at the eastern end of the section. The junction between the London Clay and the overlying Bracklesham Group is unexposed (Daley *in* Daley and Balson 1999).

The fish assemblage occurs almost exclusively in the Aldwick Beds of the London Clay Division B, although Venables (1963, pp. 259–60) records the teleost *Cylindracanthus rectus* (Dixon) from the Starfish Bed of Division A3. Division B of King (1981) has a varied fauna and flora, much of which is preserved in pyrite. The invertebrate fauna of the fossiliferous horizons, a silty clay rich in molluscan shell debris, is somewhat different from that of the typical London Clay. Pyrite also occurs abundantly as small grains and nodules thoughout Division B. Amongst the pyritized fossils are insects and beetles (Britton, 1960; Venables and Taylor, 1963), that occur in association with a large assemblage of land-derived seeds and fruit, and fish remains, in the foreshore exposures of Divisions B1 and B2 (King, 1981, p. 73). Although fish remains can be recovered directly from the fossiliferous units, when these are exposed at low tide,

some of the best material is found in the natural concentrates of pyritic debris or ‘pyrite pools', and the beach sand can itself be sieved for tiny fish teeth and otoliths. Fish material from these accumulations is invariably disarticulated, but the preservation is very good (Figure14.7). Scattered phosphatic nodules are also common in the Aldwick Beds, and these contain abundant semi-articulated fish remains, as well as crustaceans, nautiloids and reptile material (Daley *in*Daley and Balson, 1999).

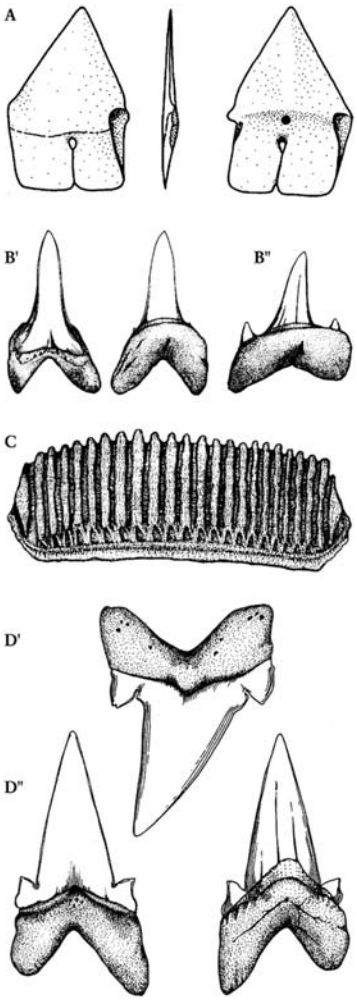

Figure 14.7: Fossil fishes from the London Clay at Bognor Regis. (A) labial, mesial and lingual views of Isistius triangularis (Probst), lower lateral tooth (after Capetta, 1987), × 9; (B) Isurolamna affinis (Casier): (B') anterior tooth, labial and lingual views × 2; (B") antero-lateral tooth, labial view × 2; (C) Myliobatis dixoni Agassiz median tooth, basal view, × 2; (D) Otodus obliquus Agassiz: (D') upper lateral tooth labial view × 1; (D") lower anterior tooth, lingual and labial views, × 1. (B)–(D) from Kemp et al., 1990).

Fauna

The fauna listed below is recorded from the classic work ofVenables (1963) and lists in Casier (1966) and Ward (1980). Otoliths from this locality have been studied by Stinton (1957, 1965c, 1975–1980).

Chondrichthyes: Elasmobranchii: Neoselachii: Squalomorphii

Heterodontus sp.

Isistius trituratus (Winkler, 1874)

Notorhynchus serratissimus (Agassiz, 1844)

Squalus minor (Leriche, 1902)

Chondrichthyes: Elasmobranchii: Neoselachii: Squatinomorphii

Squatina prima (Winkler, 1874)

Chondrichthyes: Elasmobranchii: Neoselachii: Galeomorphii**Anomotodon sheppeyensis** (Casier, 1966)

Carcharias hopei (Agassiz, 1843)

Carcharhinus (Hypoprion) sp.

Galeorhinus lefevrei (Daimeries, 1891)

G. formosus Arambourg, 1952

Heterodontus vincenti (Leriche, 1905)

H. wardenensis Casier 1966

Isurolamna affinis (Casier, 1946) (= *Lamna affinis*, *L. inflata*)

Isurus praecursor (Leriche, 1905)

Jaekelotodus trigonalis (Jaekel 1895)

'*Lamna*'*lerichei* (Casier, 1946) (= *L. vin- centi*)

Odontaspis winkleri (Leriche, 1905)

Otodus obliquus Agassiz, 1836

Oxyrhina sp.

Physogaleus secundus (Winkler, 1874) (= *Physodon secundus*, *P. tertius*, *Galeorhinus minor*)

Scyliorhinus gilberti Casier, 1946

'*Scyliorhinus*'*minutissimus* (Winkler, 1873)

'*S.. biauriculatus* (Casier, 1950)

Synodontaspis macrotus (Agassiz, 1843)

S. robustus (Leriche, 1905)

Chondrichthyes: Elasmobranchii: Neoselachii: Batomorphii

Burnhamia (Rhinoptera) daviesi (Woodward, 1889)

Dasyatis duponti (Winkler, 1874)

D. tricuspidata Casier, 1946

Myliobatis dixoni Agassiz, 1843

M. toliapicus Agassiz, 1843

Myliobatis sp.

Raja sp.

Chondrichthyes: Holocephali: Chimaeriformes

Elasmodus hunteri Egerton, 1843

Chimaera sp.

Osteichthyes: Actinopterygii: Teleostei: Elopomorpha

Albula oweni Leriche, 1905

Osteichthyes: Actinopterygii: Neopterygii: Euteleostei

Cylindracanthus rectus (Dixon, 1850)

Egertonia isodonta Cocchi, 1866

Eutrichiurides winkleri Casier, 1946

Palaeogadus (Trichiurides) sagittidens (Winkler, 1874) *Sciaenurus bowerbanki* Agassiz, 1845

Scomberomorus sp.

Sphyraena sp.

Undifferentiated 'teleosts'

Siluroid spine, cf. *Arius* sp.

Pseudosphaerodon sp.

Platylaemus sp.

Glyptorhynchus sp.

Interpretation

The fish-bearing horizons within the Aldwick Beds of the London Clay at Bognor Regis represent deposition within a nearshore marine environment at the eastern edge of the Hampshire Basin. Depths of less than 70 m have been postulated by Hewitt (1988a, 1988b) based upon his studies of nautilid fossils. A nearshore environment is also suggested by the abundance of well-preserved insect and beetle material (Jarzembowski, 1991) and drifted plant matter (Chandler, 1964). The Bognor assemblages suggest that the palaeoclimate was similar to the humid, subtropical conditions of the Mediterranean (Collinson, 1983).

The list of fossil fishes is impressive, with 34 species of elasmobranchs, two holocephalians and 21 species of actinopterygians (and 26 species of otoliths) at least. In an inshore environment, as is suggested here, the possibility of occasional catastrophic mixing of vertebrate remains from different habitats cannot be ruled out. This might account for the diversity and richness of the fauna. Nevertheless, the vertebrates of the nearshore neritic zone would have occupied a wide variety of ecological niches, as is borne out by the range of taxa present. The large number of predatory elasmobranchs is witness to the high productivity of the local waters, and the range of teleosts suggests a variety of feeding patterns at several levels within the broad trophic pyramid. Populations were probably very high per unit area of the depositional basin, again this is consistent with the postulated subtropical (Mediterranean-like) conditions.

Comparison with other localities

Similar London Clay, Division B, faunas have been recovered from Alum Bay and Whitecliff Bay (SZ305855) on the Isle of Wight, where material is winnowed from levels in the cliff. At Bognor the remains are washed out of foreshore exposures forming patchy pyritic accumulations on the shoreline. Consequen-tly, the fish debris suffers less abrasion and weathering than at other sites. Fossils are also much more accessible at Bognor as the shallow dip produces wider outcrops along the foreshore, contrasting with the narrow exposures of the near-vertical cliff faces at Alum and Whitecliff Bays, where the lowermost beds of the Division B are almost always badly slipped and poorly exposed.

The foreshore exposures of London Clay, Division B, at Swalecliff, Kent (TR 1367) are littered with phosphatized nodules which occasionally yield whole fish specimens (D. Ward, pers. comm., 1994). The same horizon at Maylandsea, Essex (TL 908035), has also yielded abundant microvertebrate material.

Conclusions

Bognor Regis is the only locality in the Hamp-shire Basin to produce fossil fish material from the London Clay Formation, Division B, in any quantity, thus its conservation value. The fossiliferous horizons can still be sampled at beach exposures, should produce more material.

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