Chapter 13 British Cretaceous fossil fishes sites

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Introduction: palaeogeography and stratigraphy

The Cretaceous System in Britain (Figure 13.1) and (Figure 13.2) is represented by two broad phases of deposition which relate to palaeogeography. Earth movements during the Late Jurassic uplifted most of north-west Europe to form land. In the British region, there were initially two main basins of deposition, in the East Anglia–North Sea area, and in the Weald and northern France. Facies of the Early Cretaceous were deposited subaerially or in relatively shallow-water marine and freshwater environments, represented by lagoonal, fluvial and lacustrine sediments of the Purbeck and Wealden, and by shallow-marine shelf facies of the Lower Greensand, Gault and Upper Greensand. Following a major transgression in Mid-Cretaceous times, seas flooded most of the British area, leaving small patches of land only in the mountainous areas of North Wales, eastern Ireland, southern Scotland, and the Scottish Highlands. Late Cretaceous history in Britain is dominated by the predominantly coc-colith limestone facies of the Chalk.

The Cretaceous has been zoned primarily on the basis of ammonites and belemnites, but the relative, or complete, absence of these fossils from much of the sequence gives a poorer overall macrofossil stratigraphical resolution than for the Jurassic. Even in the marine Late Cretaceous Chalk facies, selective preservation, probably because of sea-floor dissolution, has limited the ammonites to discrete horizons (Kennedy, 1969), and schemes of correlation have involved the use of inoceramids, belemnites, brachiopods and echinoderms. Micropalaeontological dating, especially with foraminiferans, is used in the absence of macrofossils (Figure 13.2).

Environments

Late Jurassic to Early Cretaceous earth movements led to the development of regressive facies over much of northern Europe and England, and in Britain the base of the Cretaceous System falls in the non-marine Purbeck Beds and within the Norfolk–Lincolnshire marine sequence (Allen and Wimbledon, 1991). The succeeding Wealden Group consists of lagoonal, fluvial and lacustrine deposits which crop out over an extensive area of Sussex, Surrey and Kent (the Weald area) and on the Isle of Wight and in Dorset–Wessex area. The Wealden of the Weald sub-basin (Berriasian–Barremian) falls into two divisions: the lower sand-dominated Hastings Beds and the upper Weald Clay.

The Hastings Beds consist of predominantly sandy, but often argillaceous, deposits which reach a maximum thickness of *c.* 400 m in the centre of the Weald; three major cycles of sedimentation can be identified (= Ashdown Beds + Wadhurst Clay, Lower Tunbridge Wells Sand + Grinstead Clay and, less well developed, Upper Tunbridge Wells Sand). The base of each cycle commences with clays and mudstones, which gradually coarsen upwards into cross-bedded sandstones. The uppermost beds may include pockets and lenses of bone-rich gravel, passing upwards into cross-laminated siltstones with the horsetail *Equisetites.* A return to argillaceous rocks forms the base of the following cycle. These sediments have been interpreted as deltaic, but the work of P Allen (1976, 1981a) indicates that they were deposited in lagoonal to lacustrine mudplain environments in which salinity was controlled by the rate of surface freshwater runoff. Soil horizons, dinosaur footprints (Norman, 1987) and the common remains of in-situ horsetail roots and stems are testimony to the maintenance of shallow-water conditions of deposition throughout.

The Weald Clay, above the Hastings Beds, with a maximum thickness of 450 m, was deposited almost exclusively in mudplain environments, with occasional localized influxes of coarser sediment (P. Allen, 1976, 1981a). The incoming of typically marine fossils toward the top of the Weald Clay (e.g. echinoderms and oysters) documents the initial phases of the main Cretaceous transgression and subsequent deposition of the Lower Greensand across southern and eastern England during the Aptian and Albian stages.

The Wealden Group (Berriasian–Aptian; Kerth and Hailwood, 1988) in the Wessex sub-basin comprises the Wessex Formation (formerly Wealden Marls) and the overlying Vectis Formation (formerly Wealden Shales). The Wessex

Formation is a sequence of alternations of mainly red, mudstones with subordinate sandstones. The unit thins from about 530 m below the Isle of Wight to 70 m in Dorset. Sedimentological and palaeoecological evidence indicates that the Wessex Formation was deposited on an alluvial plain crossed by a perennial meandering river system (Daley and Stewart, 1979; Stewart, 1981a, 1981b, 1983). The Vectis Formation comprises mainly grey mudstones and siltstones, usually organized in thin fining-upwards cycles. It is about 60 m thick on the Isle of Wight, but thins westwards into Dorset, where it is absent in some sections. The Vectis Formation was deposited in a shallow coastal lagoon that was subject to increasing salinity and storm frequency towards the top (Stewart *et al.,* 1991; Wach and Ruffell, 1991).

The Lower Greensand consists of a series of mudstone and sandstone facies with a rich marine fauna (bivalves, especially oysters, gastropods, brachiopods, echinoids and ammonites), and is assumed to have been laid down in marine and nearshore marine environments, with frequent estuarine intercalations in the Isle of Wight (Wach and Ruffell, 1991).

Lower Greensand deposition over much of southern and south-eastern England was terminated by a further transgression which, during the early Albian, led to widespread development of basinal marine mudstone facies (the Gault Clay Formation). These argillaceous deposits are commonly highly condensed, and phosphatic nodule horizons may be present. Westwards, the facies passes laterally into the Upper Greensand Formation, a variable, often biotur-bated deposit of glauconitic sands. This unit contains abundant marine fossils, such as bivalves (especially oysters) and serpulid worms. In Cambridgeshire, Albian fossils are reworked into the Cenomanian Cambridge Greensand. Farther north (from Norfolk into the North Sea) the Gault passes laterally into the condensed carbonate sequences of the Carstone and Red Chalk, or Hunstanton Red Rock (Hunstanton Formation).

Transgression, initiated in the Aptian, continued until the close of the Cretaceous and brought changes which led to massive developments of coccolith ooze interbedded with marls that now form the Chalk. The base of the Chalk is marked by a condensed marly deposit, known as the 'basement bed', which contains abundant quartz, glauconite and reworked phosphatized fossils. Above this, the Chalk sedimentation is characterized by rhythmically alternating chalky limestones and interbedded marls. Sedimentation was only interrupted during the Turonian, when a strongly regressive phase led to deposition of 'nodular chalk' with some associated hardgrounds.

The Late Cretaceous sea submerged much of the denuded European craton, so that there was very little terrigenous input during Chalk deposition. The soft limestones and marls of the Chalk are intensely bioturbated and represent deposition within warm clear water, at depths of 100–600 m (Hancock, 1975). Normal marine salinities are indicated by the presence of echinoderms, brachiopods and cephalopods, but substrate conditions were probably very soft, inhibiting a proper benthic community. Over submerged massifs, the chalk facies thins, and stratigraphical gaps are present. In these regions, condensed hardground horizons (for example the 'Chalk Rock') can form and these are characterized by encrusting organisms, phos-phatized fossils and glauconite. The European Chalk contains abundant flint nodules which formed from the dissolution and reprecipitation of biogenic silica (e.g. sponge spicules) during early diagenesis (Sieveking and Hart, 1986).

The end of the Cretaceous (late Maastrichtian) saw a substantial marine regression in Britain and much of Europe. This coincided with a major phase of extinction of many groups of invertebrates and vertebrates; among marine invertebrates, the ammonoids, belemnites, inoceramids and nudists became extinct.

Cretaceous fish faunas chart an important watershed in the history of the bony fishes, as the archaic, dominantly non-teleost, neopterygian faunas typical of the early Mesozoic were replaced by the teleosts, which are the dominant group of bony fishes in late Cretaceous, Tertiary and modern aquatic environments. The evolution of the fishes during the long Cretaceous period was typified by the expansion of the higher bony fishes towards the end of that time (Stinton, 1973). They appear to have diversified in form, habit and mode of life, and to have become abundant in most of the seas and oceans. Important marine groups such as the herrings (clupeomorphs) and mackerel (gadi-iforms) were established, and in the later half of the period some very large predatory forms were present. In contrast, the primitive actinopterygians fishes did not reach the end of Cretaceous time in such numbers as they had at the beginning of the period. They included such successful types as the Pholidophoridae (a Triassic and Jurassic group from which the teleosts may have sprung), *Aspidorhynchus* (amiids) and the ancient gars, but their overall numbers were declining. The

Chondrostei too were in decline. The coelacanths and freshwater lungfishes were not common, but survived throughout the period. The coelacanths were relatively few. Until 1938 they were thought to have died out at the end of the Cretaceous, but were then found in deep water off the coast of East Africa. Cretaceous lungfishes, like the Jurassic species, belong only to the Ceratodidae, an extant freshwater family.

Teleost evolution included the development from the Jurassic pholidophorids and the slightly more advanced Leptolepidae of five major groups: the Osteoglossomorpha, Elopomorpha, Clupeomorpha and the Euteleostei, which survive to the present day, and the now extinct, but prominent, Cretaceous Ichthyodectidae (Patterson and Rosen, 1977). Most were marine. All the Late Jurassic and Early Cretaceous fossils regarded as predecessors of the modern teleost groups were very similar in overall morphology (e.g. the Leptolepidae). The Osteoglossomorpha are cosmopolitan in the fossil record and are now freshwater predators in southern continents and North America, and include the largest extant freshwater fish, e.g. *Arapairna* (*c.* 5 m long) from Brazil. The other cohorts and subcohorts have throughout the Cenozoic followed the euteleosts in diversification and adaptation to new habitats. Their development is discussed below.

Amongst the chondrichthyans there were very few innovations, but the Wealden (Lower Cretaceous) shark fauna of southern Britain is unusual in being predominantly freshwater in habitat and containing only hybodonts. It has been suggested that the hybodonts escaped competition with more advanced neoselachian sharks by entering fresh water. Some of the more specialized Wealden hybodonts seem to have given rise to the Upper Cretaceous hybodonts and ptychodonts, which are marine forms. The palatal crushing teeth of the pty-chodont *Ptychodus* were once so common in the British Lower Chalk that they were known as 'fossil slugs' by quarrymen.

Amphibians have never been recorded from the Cretaceous succession in Britain.

Early Cretaceous: Wealden Group (Berriasian–Barremian)

The lagoonal, lacustrine and fluvial deposits of the Wealden Group of the Weald and the Isle of Wight are famed for their freshwater fish beds (Figure 13.3). The Brook-Atherfield section on the south-west coast of the Isle of Wight exceeds the contemporaneous vertebrate-rich sediments of Mongolia and the USA both in the abundance and variety of the material.

The Wealden of the Weald (Berriasian–Barremian) is well known for its fossil fishes, and specimens have come from many localities, most of which are inland extractive sites (clay pits) and are no longer accessible. Fish material is known from all Wealden formations, but occurs most frequently in the Hastings Beds. The succeeding Weald Clay has yielded fewer fish remains, although scattered scales and teeth are common in many horizons. The Bexhill–Hastings region has produced three-dimensional specimens of *Lepidotes* and hybodont sharks preserved in ironstone noules.

Fish sites

Specific localities in the Wealden of the Weald include:

WEST SUSSEX: Longbrook Brickworks ([TQ 117 188]; fishes; Wells Collection); Henfield Brickworks ([TQ 220 143]; *Hybodus basanus, H. brevicostatus* (holotype), *H. parvidens, Hylaeobatis ornata, Lissodus breve breve, L. striatum* (holotype), *Coelodus mantelli, Lepidotes mantelli, Pachythrissops* sp., '*Clupavus*'sp., *Caturus tenuidens;* Patterson, 1966; Tilgate Forest ([TQ 27 35], exact localities uncertain; *Coelodus mantelli, Lepidotes mantelli, Pachythrissops* sp., '*Clupavus*' sp., *Caturus tenuidens;* Patterson, 1966; Tilgate Forest ([TQ 27 35], exact localities uncertain; *Coelodus mantelli, Lepidotes mantelli,* '*Asteracanthus granulosus*'(= *?Hybodusensis* (Patterson, 1966)), '*Acrodus birudo*'(= *?Hylaeobatis problematica*)*, Hybodus brevicostatus, 'Hybodus striatulus*', '*H. elongatus*','*H. subcannus*','*H. sulcatus*','*Oxyrhina paradoxa*'[= *?Sphenodus*]; Topley, 1875); Cuckfield ([TQ 300 256], now largely infilled; *Lepidotes mantelli;* White, 1924, p. 9); Keymer Tileworks ([TQ 325 189]; microvertebrates, including *Lepidotes* spp., and indeterminate fish remains; Cook, 1995); Wivelsfield ([TQ 34 20]; various localities with fossil fishes; Young and Lake, 1988, p. 23); Philpotts Quarry ([TQ 355 322]; articulated specimens of *Pachythrissops* sp.; Allen, 1976, p. 401); Homeland, Ashurstwood ([TQ 419 363]; *Lissodus breve breve, L. breve crenulatum;* Patterson, 1966).

EAST SUSSEX: Bexhill–Cooden Beach ([TQ 715 062]–[TQ 750 070]; *Hybodus basanus, Hybodus* sp., *Hylaeobatis ornata,* batoid, *Lepidotes mantelli, Coelodus* sp., *Caturus* (*Callopterus*) *latidens* Woodward, 1918 (holotype), *Neorbombolepis valdensis* Woodward, 1895 (holotype); Woodward, 1895a, 1918; Patterson, 1966; Lake and Shephard-Thorn, 1987); Hastings ([TQ 831 095]–[TQ 853 105]; various localities along the foreshore; 11 species, see site report; White, 1928; Allen, 1949, 1960; Clemens, 1963; Patterson, 1966); West Marina Quarry, St Leonards-on-Sea ([TQ 78 08]; *Lepidotes* spp., *Hybodus parvidens, Hybodus* spp.; Allen, 1947, 1949); Castle Farm, Mountfield ([TQ 73 20]; *Hybodus* spp., *Lepidotes* spp.; Allen, 1949); Black Horse Quarry, Telham ([TQ 769 142]; *Lepidotes* sp., *Coelodus* sp., *Hybodus* sp., coprolites; Topley, 1875; White, 1928; Lake and Shephard-Thorn, 1987); Telham Farm Quarry, Telham (*Lepidotes* spp., *Hybodus* spp.; Topley, 1875, pp. 63–4, White, 1928); Crowhurst stone pit, Rockwell Wood ([TQ 764 124]; *Hyleaobatis ornata, Lepidotes mantelli;* Sweeting, 1925; Patterson, 1966); Baldslow ([TQ 80 13]; *Lepidotes fittoni;* White, 1928; Allen, 1949); Hare Farm Lane, Brede ([TQ 832 184]; *Lepidotes* spp., *Hybodus parvidens, Hybodus* spp.; Allen, 1949); Stubb Lane, Brede ([TQ 833 187]; *Lepidotes* spp., *Hybodus parvidens, Hybodus* spp.; Allen, 1947, 1949); Brede ([TQ 82 18]; Telham Bone Bed (Wadhurst Clay) outcrops at several localities around the town; *Hybodus* spp., *Lepidotes* spp.; Allen, 1949); Ludley Hill, Beckley ([TQ 85 21]; *Hybodus* spp.; Allen, 1947, 1949); Peasmarsh, Waterwall Wood ([TQ 86 21]; *Hybodus* spp., *Lepidotes* spp.; Allen, 1949); Knellstone, Udimore ([TQ 88 19]; *Hybodus* spp., *Lepidotes* spp.; Allen, 1949); Paddockhurst Park, Turner's Hill ([TQ 34 35]); *Hybodus ensis, H. parvidens, H. brevicostatus, Lissodus breve breve* (holotype), *L. breve crenulatum* (holotype), '*Lonchidion*' *rhizion, Lepidotes* spp.; Patterson, 1966).

KENT: Tighe (Teigh) Farm, Stone ([TQ 936 266]; *Hybodus ensis, H. parvidens, Lissodus breve breve,* '*Lonchidion*' *rhizion, Lepidotes* spp.; Allen, 1949, Patterson, 1966, Lillegraven *et al.,*1979, p. 27); Stone Hole Quarry Stone ([TQ 94 28]; *Hybodus* spp., *Lepidotes* spp.; Allen, 1949); Sevenoaks, Kent ([TQ 25 55]; *Hylaeobatis ornata;* Patterson, 1966).

SURREY: Bookhurst ([TQ 07 39]; *Hybodus brevicostatus;* Patterson, 1966); Cranleigh ([TQ 05 39]; whole *Lepidotes* sp.; Allen, 1976, p. 421); Clockhouse Brickworks ([TQ 175 386]; indeterminate fish scales, fin spines, bones and teeth (including *Hybodus* spp. and *Lepidotes* spp.), egg cases (*Spirangium jugleri* Schrimper: ?hybodont shark), teleost scales, and coprolites; Jarzembowski, 1991); Auclaye Brickworks ([TQ 170 388]; indeterminate fish scales, bones (including *Lepidotes* spp.) and egg cases (*Spirangium jugleri* Schrimper: ?hybodont shark) ; Jarzembowski, 1991) ; Smokejacks Brickworks, Ockley ([TQ 113 373]; fish fragments (including *Lepidotes* spp. and *Hybodus* spp.) and egg cases (*Spirangium jugleri* Schrimper: ?hybodont shark); Jarzembowski, 1991); Meadvale, Redhill ([TQ 27 50]; *Hylaeobatis ornata;* Patterson, 1966).

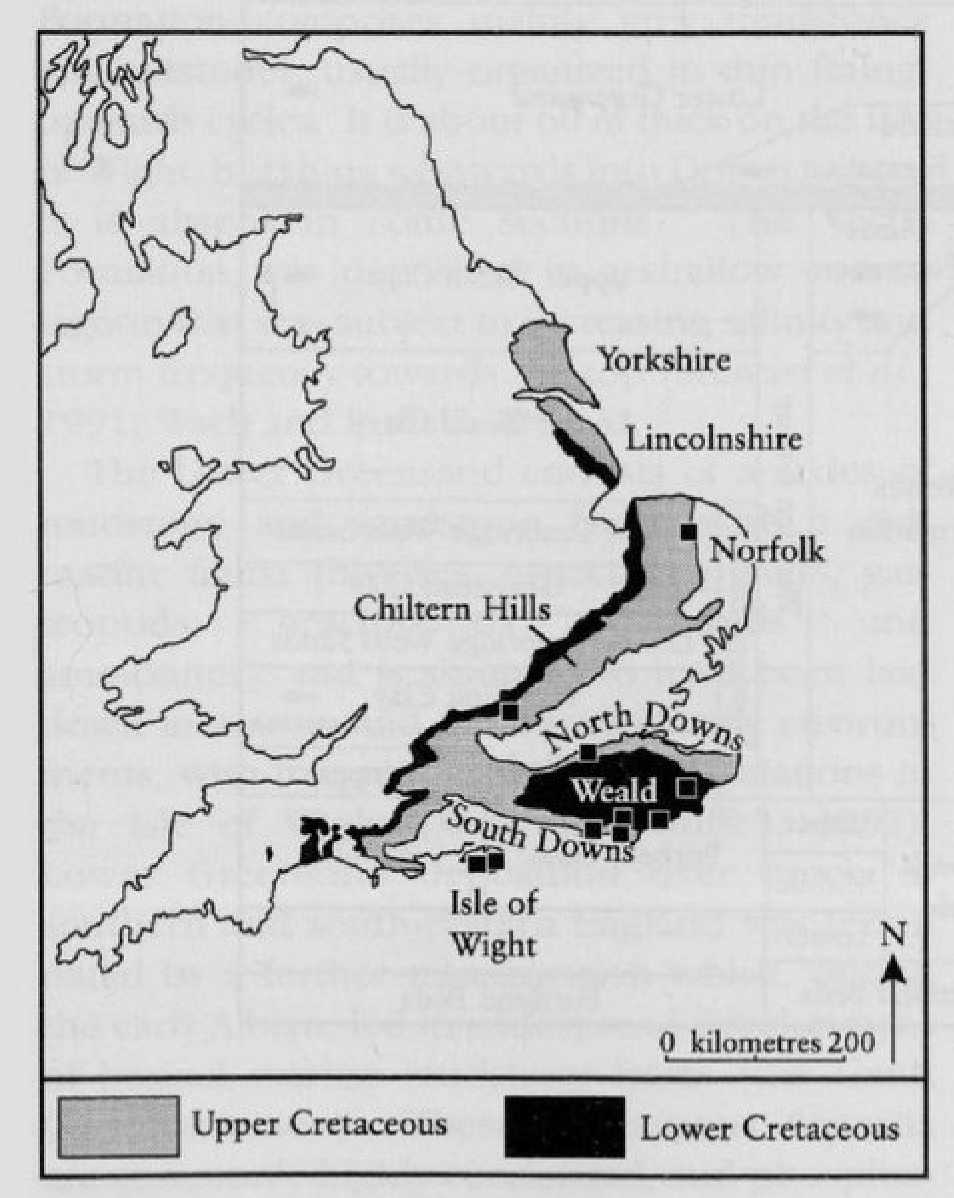
In the Isle of Wight the Wealden beds are represented by predominantly argillaceous facies of the Wealden Marls and Wealden Shales (Wessex and Vectis Formations), which are best seen in the coast sections between Brook and Atherfield Point in the south-west (see site report) and at Yaverland, near Sandown [SZ 613 850] in the south-east. Isolated fish remains occur in most horizons within these sections.

In Europe, comparable Wealden fossil fish faunas are known from the Bernissart coal mines, Belgium (Norman, 1980), France (Buffetaut and Leloeuff, 1991), Hannover, Germany and North America (Cloverly Formation, Wyoming; Ostrom, 1970; Morrison Formation, Wyoming; Dodson *et al.,* 1980).

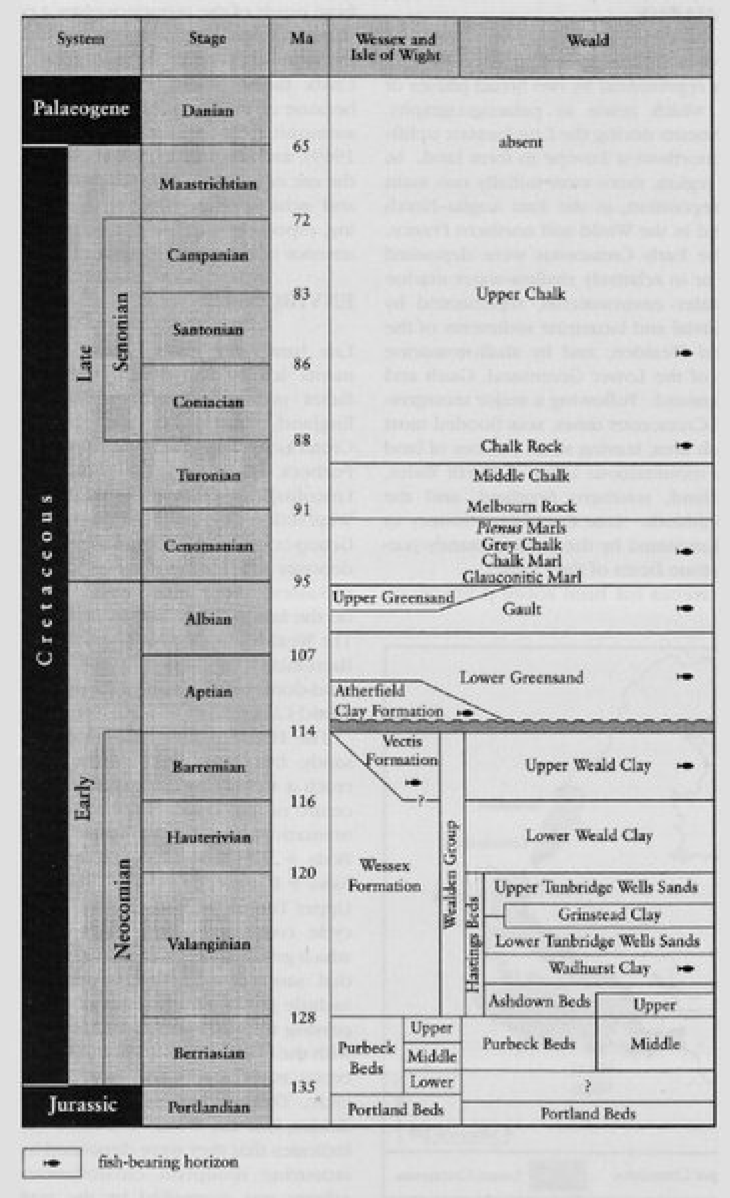
Of the classic early Cretaceous fish sites in the Wealden of southern Britain, two sites were selected for inclusion within the GCR, one in the Hastings Beds of East Sussex and the other in the Wealden of the Isle of Wight:

1. Hastings, East Sussex ([TQ 831 095]–[TQ 887 129]). Early Cretaceous (Berriasian–Valanginian), Hastings Beds (Ashdown Beds).
2. Brook–Atherfield Point, Isle of Wight ([SZ 375 842]–[SZ 452 788]). Early Cretaceous (Barremian–Early Aptian), Wessex and Vectis Formations.

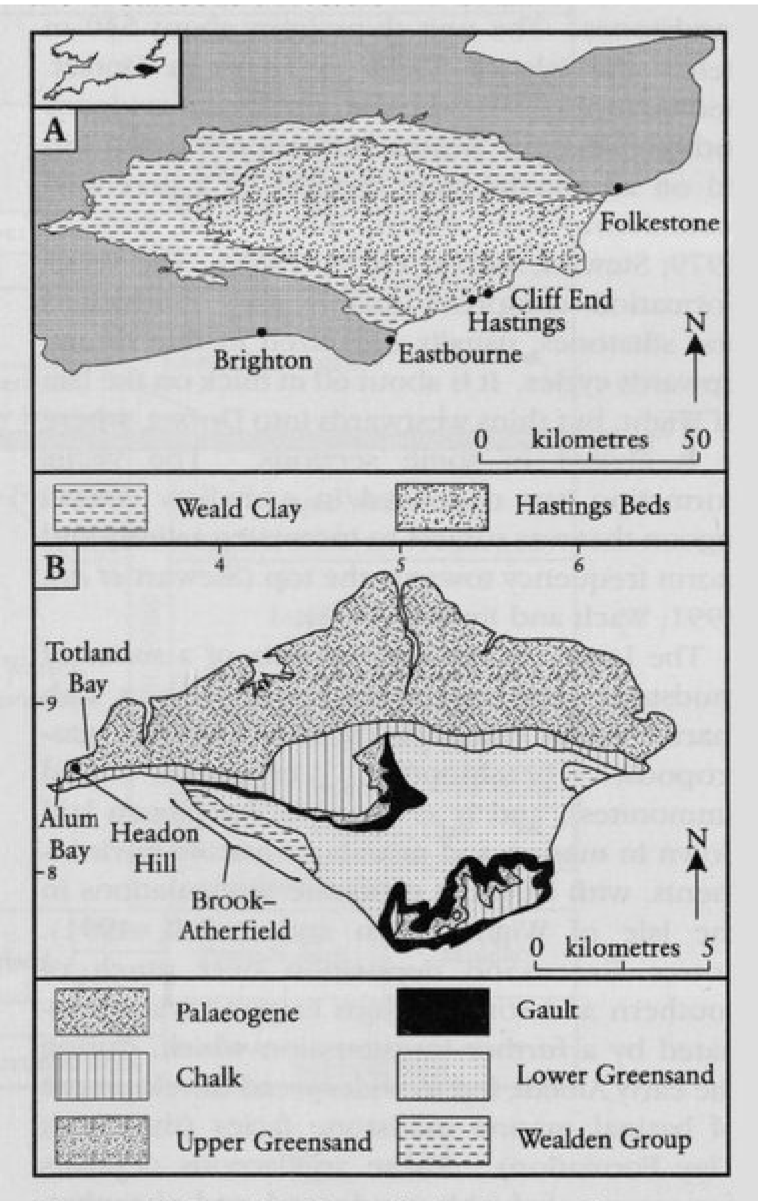
References



(Figure 13.1) Map of outcrop of Cretaceous with GCR fish sites indicated (from Benton and Spencer, 1995).



(Figure 13.2) Cretaceous stratigraphy (from Benton and Spencer, 1995).



(Figure 13.3) (A) Map of the Lower Cretaceous Hastings Formation (Beds) and Weald Clay Formation of the Weald area of southeast England (after Cook, 1995); (B) geological map of Isle of Wight.