Chapter 12 British Jurassic fossil fishes sites

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Introduction: palaeogeography and stratigraphy

In Britain, rocks of Jurassic age occur in a long, almost continuous outcrop running from Dorset to Yorkshire, and in scattered patches in the islands off north-west Scotland, and in north east Scotland (Figure 12.1). Following the onset of North Atlantic rifting and the fragmentation of the Late Palaeozoic supercontinent 'Pangaea' in the late Triassic and early Jurassic (Pitman and Talwani, 1972), marine conditions spread over much of the low-lying marginal alluvial plains during the Rhaetian transgression (latest Triassic). By the early Jurassic, a marine transgression had transformed much of northern Europe into an enormous, shallow epeiric sea. Britain occupied a western marginal position of overlap between the Tethyan and Boreal faunal realms. The Fenno-Scandinavian shield was the nearest landmass of any size (Sellwood and Jenkyns, 1975) and landscape relief everywhere appears to have been low. In Britain there were small emergent islands that were fringed by coalescent deltas, coastal marshes and low-lying alluvial plains building out into the shallow sea.

The London–Brabant massif and the Cornubian island formed the major landmasses in the south of England; to the south lay the open sea of the Weald, Channel and Paris basins (Megnien and Megnien, 1980). Between the Welsh, Pennine and London–Brabant landmasses the fairly shallow-water marginal–marine conditions of the Midland or Cotswold–Weald Shelf prevailed. To the north of the London–Brabant land, alluvial and marginal marine deposits were deposited in the Cleveland Basin. Sedimentation into this basin seems to have been predominantly from the Scottish landmass and Central North Sea High (Thomas, 1975). Volcanic doming around the junction between three structural graben also contributed to high sedimentation rates in the northern North Sea (Bradshaw *et al.,* 1992).

The Jurassic System is represented by rocks of predominantly shallow marine origin, with mainly fine-grained sediments such as marine shales, clays and mudstones. Shallower facies, marked by greater terrestrial content, include deltaic sequences of clays and sandstones, while those with little terrestrial input include shelf carbonates. The latter carbonates are characteristic of the Mid Jurassic (Aalenian–Bathonian) and Late Jurassic (Oxfordian and Portlandian) and are commonly oolitic in character.

Rich faunas of ammonites allow precise biostratigraphical correlation for most of the Jurassic (Figure 12.2). Within the Early Jurassic, for example, a time span of about 25 Ma, 20 ammonite zones are recognized, and each is further subdivided into subzones. Where ammonites are scarce or lacking, as is the case in some British Mid- and latest Jurassic terrestrial sediments, correlations have been attempted using other fossils, most commonly foraminifera, ostracods, non-marine molluscs, dinoflagellates, spores and pollen, but these give a lower resolution.

Environments

The onset of marine conditions in Britain was marked by the Rhaetian transgression in the latest Triassic (documented in the rocks of the Penarth Group), and by the Early Jurassic fully marine conditions had become established. A shallow, epicontinental and organically highly productive sea flooded much of northern Europe (Figure 12.3). The extensive shelf area gave protection from strong tidal or storm influences, and distinctive facies of laminated bituminous shales and rhythmic sequences of lime mud and marl accumulated. Over shallow regions (swells), oolitic ironstones and condensed cephalopod limestones developed in the relative absence of terrigenous input.

Marine conditions continued through much of Jurassic time with major regressive intervals, during the Middle Jurassic and at the close of the Jurassic, when the area of epeiric seas became significantly reduced, eventually giving way to the subaerial facies of the Portland and Purbeck beds.

The lowest units of the British Jurassic (Lias) consist primarily of marine clay–shale facies, which in outcrop are more calcareous in the south and more sandy in the north. Two principal shale groups, those of the early and later Lias are developed and are separated by the shallower-water facies of sandy shales, sandstones and oolitic ironstones of the Middle Lias. Fine-grained yellow sands of Upper Lias and earliest Bajocian age (e.g. Bridport sands) crop out from Gloucester southwards to the Dorset coast. The biota of the Lias is dominated by marine benthic forms that indicate rather harsh bottom conditions. However, at times, environmental conditions appear to have deteriorated further so that only very low-diversity invertebrate fossil faunas occur. The sequences of unbioturbated bituminous laminated shales, characterized by the Jet Rock of Yorkshire, lack even protobranch bivalves, and represent the onset of anoxic bottom conditions. Under these conditions, mid-water nekton died, sank and were deposited undisturbed; consequently such sequences contain some of the best examples of the marine vertebrates of the time.

Bathonian times in the Mid-Jurassic were characterized by regressive facies. Fluvio-deltaic deposits were laid down in southern Britain while, in west Scotland, the Great Estuarine Group accumulated under lagoonal conditions. At the same time, lagoonal–marsh and marginal–marine conditions appear to have developed in central England, where characteristic terrigenous deposits are found. The contemporaneous rocks in southern England are rather different, being dominated by marine carbonates with only a small terrigenous component of clays (e.g. the Great Oolite and the Fuller's Earth), and these appear in the Cotswolds and the south Midlands to represent nearshore deposition, with signs of subaerial exposure. Ammonites there are consequently rare and correlation is difficult (Arkell, 1931).

The succeeding rocks demonstrate a resumption of marine elastic sedimentation following commencement of the second major transgressive phase during the Callovian. The facies are predominantly monotonous, laterally extensive, dark bituminous clays which, in essence, mark a return to restricted muddy marine environments like those of the Early Jurassic (Duff, 1975). In southern Britain, these beds are represented by the Lower Oxford Clay. The deeper-water Kimmeridge Clay (clays, mudstones and shales) is comparable, being rich in preserved organic material (including kerogen) and containing a restricted marine benthos.

The Portland Group shows evidence of shallowing and renewed regression, and preserves a range of facies. The Cherry Beds are rich in sponge spicules and seem to have been deposited in calm deep marine water. The upper parts of the succession include oolites, micrites, and eventually evaporites (represented by halite and anhydrite) and soils, which document the progress of the regression. Marine incursions, including the Cinder Bed 'event', occur in the mid- to late Purbeck beds, which are otherwise predominantly non-marine and which span the Jurassic–Cretaceous boundary.

Fish faunas

The trends in evolution set in the Triassic period were continued in the Jurassic. The most conspicuous feature of the fish assemblages is the dominance of more advanced actinopterygians, a grade of evolution to which only the gar-pikes and *Amia* (the bowfin) belong today. Chondrosteans (today's sturgeons, paddlefishes etc.) were then in decline; the coelacanths and the lungfishes, too, are both universally rare as Jurassic fossils, although some remains have been found in the British Jurassic succession. Meanwhile, the two great groups of Chondrichthyes, the Elasmobranchii and the Holocephali, are relatively common in marine strata.

A few palaeoniscoid-grade actinopterygians of relatively conservative structure lingered well into the Jurassic period. Actinopterygian evolution during this time is marked by progressive changes in the jaws and hyoid apparatus to increase the size and speed of opening of the oropharyngeal chamber. In the axial skeleton the vertebral centra became ossified and the scales became thinner and lighter, both tendencies assisting speedier swimming.

Many Jurassic neopterygians have rather deep bodies and superficially symmetrical tails; nearly all were active predators. Others developed an elongate shape. Most, though not all, were less than 1 m in length.

Mesozoic chondrichthyans show a diminished diversity of shape and structure compared with those of the Late Palaeozoic. Nevertheless the number of genera rose from seven or so in the Triassic to 41 in the Jurassic (McCune and Schaeffer, 1986). Few of the older conservative types survived. The neoselachians became the dominant forms with new developments in jaw kinetics and tooth shape. The cladodont teeth and jaws of the Palaeozoic elasmobranchs, designed for snatching and gulping, were replaced by mechanisms for cutting and gouging. As a result, prey size was no longer so critical. The anterior teeth were used to seize prey, the posterior to crush it. Fin spines were no longer so widely adopted, but claspers were retained. Hybodont sharks were common forms with simple cuspate teeth, two dorsal fin spines and claspers in the males. The ctenacanth group began a new but final radiation in the Early Jurassic and may have given rise to all modern sharks, skates and rays. The skates and rays make their appearance in the Middle Jurassic, while the Holocephali — the ratfishes and chimaeras — are well represented in the Jurassic by groups that resemble modern forms.

The Jurassic was thus a time when the extensive epeiric seas became populated by an increasingly diverse fauna of fishes. The first of the teleosts (higher bony fishes) were already present, but the 'Holosta' were declining.

Most fossil fishes obtained from the Jurassic of Britain are marine, but these are supplemented by important non-marine forms and the freshwater aquatic amphibians collected from the subaerial facies of the Middle Jurassic (e.g. Forest Marble, Stonesfield Slate). The most spectacular fish remains, and important collections, have come from the Early and Late Lias (Hettangian–Sinemurian), the Oxford Clay (Callovian) and the Kimmeridge Clay (Kimmeridgian). These fossils are commonly complete, or nearly complete, articulated skeletons, the result of undisturbed stagnant bottom waters unique to the northern European Jurassic shelf sea. The fish fauna from the Oxford Clay (Callovian) is very well preserved forming a centre-point of all international taxonomic studies.

Early Jurassic or Lias

The Early Jurassic (Lias) of Britain is famous for its marine fish faunas. Hundreds of good specimens have been obtained from localities along the entire length of the outcrop, which stretches in a continuous belt between Dorset and the Yorkshire coast. Material is housed in collections in BATM, NHM, BRSMG, CAMSM, LEICSM, OUM, SM, YORMS. Authors include Egerton (1871, 1872a, 1872b, 1873), A.S. Woodward (1886, 1889a, 1889b, 1891a,1895a, 1906), Woodward and Sherborn (1890), Fox-Strangways (1892), H.B. Woodward (1893, 1894, 1895), Arkell (1933), Gardiner (1960), Macfadyen (1970), Thies (1983), Duffin (1981, 1993b), Duffin and Ward (1983b, 1993) and Evans and Milner (1994).

The British Lower Lias has yielded abundant fish material from dozens of localities from Dorset to Yorkshire and there are at least 40 sites in the Lower Lias that have yielded scattered vertebrate material. Many of these finds are only isolated teeth and scales, so that the majority of sites may be regarded as not significant. Abundant remains have come from the quarries around Street, Somerset ([ST 48 36]) and Barrow-upon-Soar, Leicestershire [SK 58 18], but there is very little chance of more finds unless excavations are resumed. Apart from the Lyme Regis sea-cliffs, all other sites have produced only sparse remains and those that still offer exposure seem to have low potential for future finds.

The Middle Lias of England has never produced as many fossil fishes as the Lower Lias and remains are so poor that the sites are not worth tracing. A few sites in the Upper Lias of Somerset, Gloucestershire, Northamptonshire and North Yorkshire have yielded good fish specimens. In particular the 'Fish and Saurian Bed' (*exaratum* Zone, *falciferum* Subzone) exposed at Strawberry Bank, Ilminster, Somerset [ST 361 148], yielded abundant vertebrate material in the 19th century (Moore, 1852, 1856, 1866). This included fine specimens of *Caturus, Lepidotus* (=*Lepidotes*), *Leptolepis, Dapedium, Pachycormus* and *Pholidophorus,* in the Moore collection, BATM (Woodward, 1896), NHM and local museums. The quarry is now infilled (Duffin, 1978).

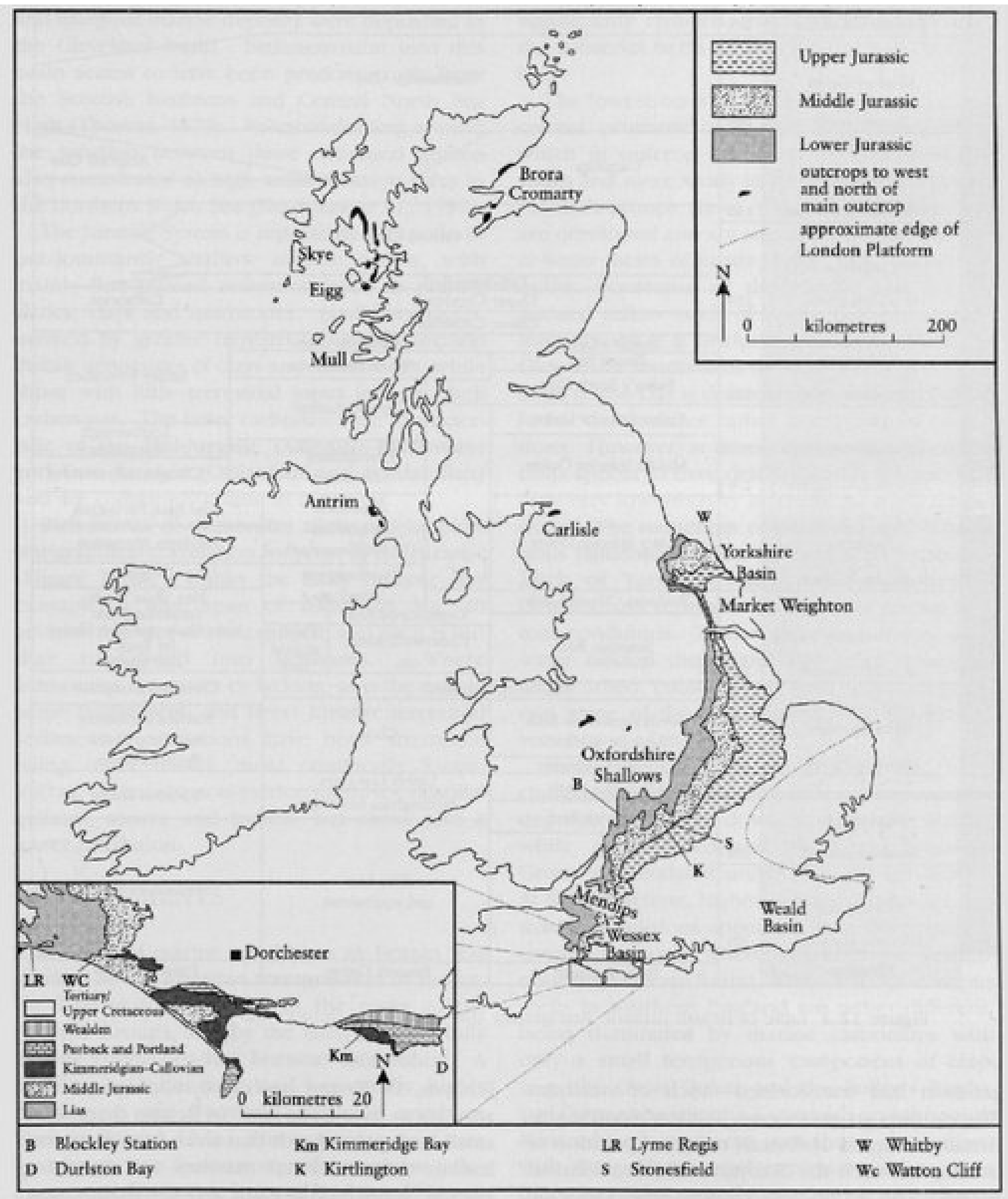
Fish sites

Three Lias localities are selected as GCR sites for their unusually prolific faunas of marine fishes:

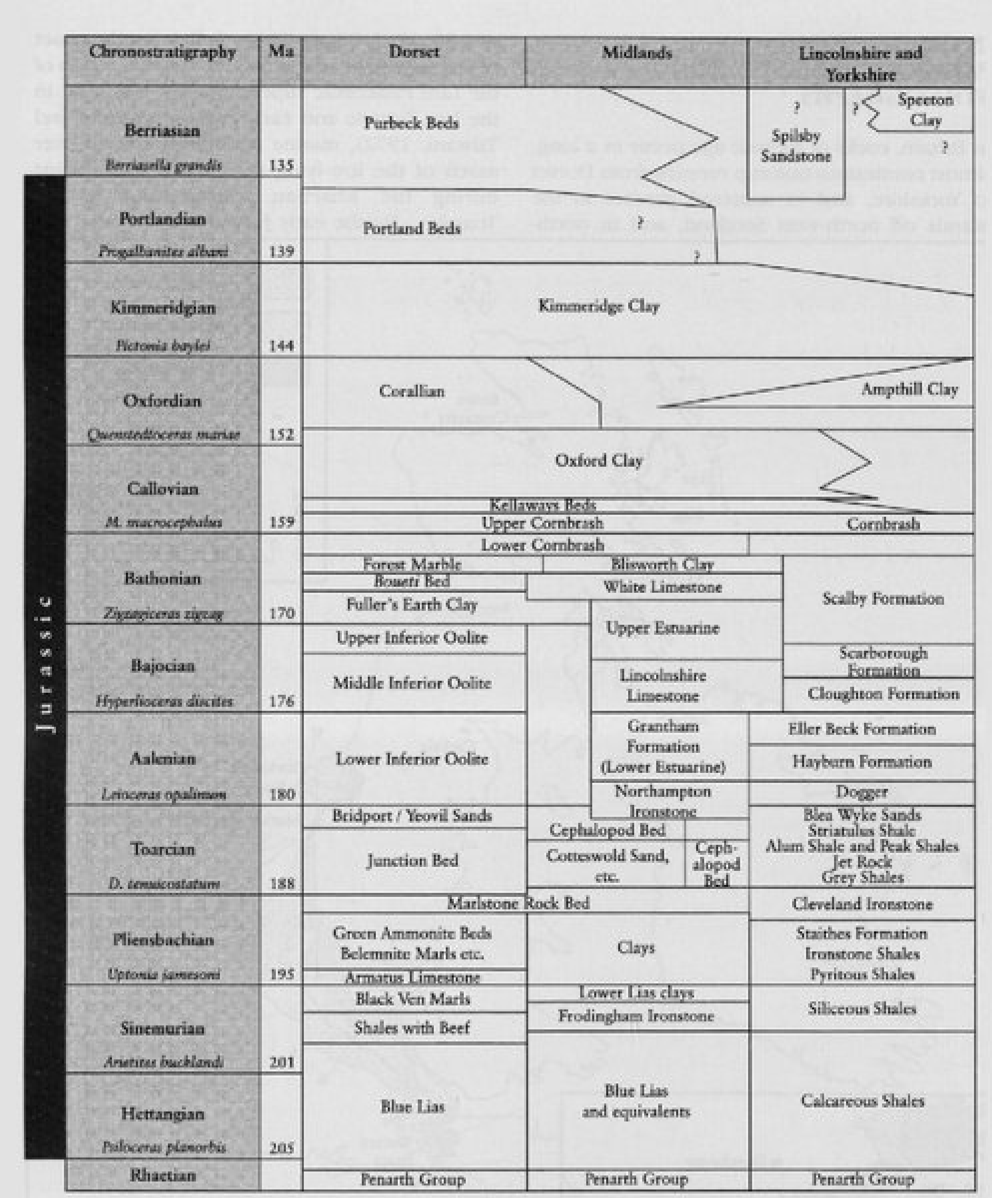
1. Lyme Regis coast (Pinhay Bay–Charmouth), Devon-Dorset [SY 325 908]–[SY 37 93]. Early Jurassic (Hettangian–Pliensbachian), Lower Lias (*Ostrea* Beds–Green Ammonite Beds).
2. Blockley Station Quarry, Gloucestershire [SP 181 370]. Early Jurassic (Pleinsbachian), Lower Lias (*?davoi Zone-ibex* Zone).

3. Whitby Coast (East Pier-Whitestone Point), North Yorkshire [NZ 901 115]–[NZ 928 104]. Early Jurassic (Toarcian), Upper Lias (Grey Shales Formation, Jet Rock Formation, Alum Shale Formation: Toarcian).

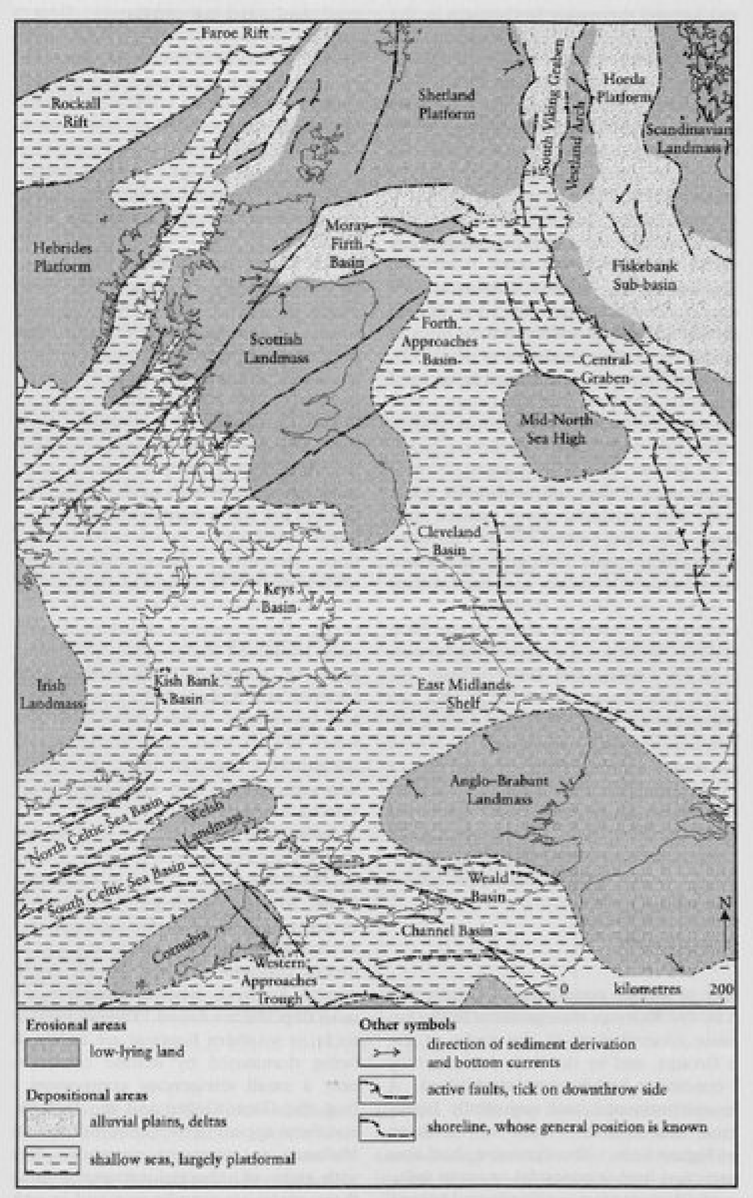
References



(Figure 12.1) Map of the outcrop of Jurassic rocks in Britain (after Benton and Spencer, 1995) with GCR sites for fossil fishes indicated.



(Figure 12.2) Table of British Jurassic stratigraphy (modified from Benton and Spencer, 1995).



(Figure 12.3) Early Jurassic palaeogeography (from Bradshaw et al., 1992).