Lyme Regis Coast (Pinhay Bay–Charmouth)

(SY 32 91)-(SY 37 93)

Highlights

Lyme Regis is the most famous British Early Jurassic fish site, and is one of the best in the world. For over 200 years abundant, articulated and well-preserved specimens of bony and cartilaginous fish have been found in the cliffs near the town. Lyme Regis is the type locality for 50 or more species of fish.

Introduction

The Lias exposures on the coast around Lyme Regis, Dorset (Figure 12.4), are world-famous for their fossil remains. Lyme Regis is historically important as the place where specimens have been collected since at least 1790 (Delair, 1969), and from 1810 to 1840 Mary Anning and her family (Tickell, 1996) found and sold many fine specimens to museums throughout the country. Around the same time, the 3rd Earl of Enniskillen (WW Cole) and Sir Philip Egerton made exceptional collections of fossil fishes. However, little stratigraphical information was provided with these early discoveries. Since then, many hundreds of specimens have been collected, and important finds are still being made.

Over 50 species of fish are recognized from here, and because of the long history of fossil collecting at this site, Lyme Regis is the type locality for many of these. Many of the remains are extremely well preserved, and beautifully articulated three-dimensional specimens have been recovered. Several complete specimens of the euselachians *Acrodus* and *Hybodus* from Lyme Regis have proved invaluable in determining the palaeobiology of hybodont sharks and in phylogenetic study of the group (Duffin, 1993b). Early neoselachians ('modern sharks', both the active predators and the skates and rays) are also present in the shark fauna (Duffin and Ward, 1993b). Chirnaeroid taxa, including many articulated specimens, are also well represented in the assemblage and Lyme Regis is the type locality for two species of squalorajoid and three species of myriacanthid holocephalians (Patterson, 1965). Lyme Regis is also the type and only locality for the coelacanth *Holophagus gulo* and many species of actinopterygians. The fish faunas have been described in detail by Egerton (1871, 1872a, 1872b, 1873), A.S. Woodward (1886, 1889a, 1889b; 1891a, 1906) and Woodward and Sherborn (1890), and more recently reviewed by Gardiner (1960), Patterson (1965) Thies (1983), Duffin (1993b) and Duffin and Ward (1993b) amongst others.

Description

In the earliest description of the Lower Lias section at Lyme Regis, the major lithological divi sions and the fossils they contained were noted (Egerton 1839). The abundance of ammonites meant that as early as the late 1850s, Oppel (1856) could adapt the zonal scheme for ammonites from the German sections to that in the Lyme Regis region. Numerous stratigraphers have provided detailed accounts of the Liassic succession at Lyme Regis (e.g. H.B. Woodward and Ussher, 1906; Lang 1914, 1924, 1932; Lang *et al.* 1923, 1928; Lang and Spath 1926; Palmer 1972). The general succession (Getty, 1980) is:

	Thickness (m)	Lang's bed numbers
unconformity		
Green Ammonite Beds	32	122–130
Belemnite Stone	0.15	121
Belemnite Marls	23	106–120
Armatus Limestone	0.4	105
Black Ven Marls	43	76–104
Shales with Beef Beds	23	54–75
Blue Lias	27	25–53

Ostrea Beds (= Pre-*planorbis* Beds) 2.5 1–24

The Blue Lias is a sequence of laterally extensive, alternating thin-bedded (and nodular) limestones and shales exposed in cliffs and on the foreshore west of the Cobb, and in Church Cliffs, just east of Lyme Regis ((Figure 12.5)A, (Figure 12.5)B. Large ammonites and bivalves are abundant in certain limestone beds. The Shales with Beef Beds between Lyme Regis and Charmouth consist of thin, papery, dark shales, marls and limestone nodule beds with much fibrous calcite (toed), pyrite and selenite. Fossils include ammonites, poorly preserved bivalves, belem-nites and numerous fishes, commonly complete. The Black Ven Marls, in the cliff and foreshore west and east of Charmouth, consist of blue-black mudstones and paper shales with occasional limestones. Many species of fish along with ammonites, bivalves, brachiopods, foraminifers and insects occur in these beds. Deposition of all sediments was marine and, although not marginal or intertidal, was probably close to shore because of the presence of insect, plant and dinosaur remains. The overlying Belemnite Marls consist of light grey marls with abundant lignite interbedded with dark grey shaky marls and capped by a thin limestone, the Belemnite Stone. These beds contain an abundant mollusc fauna and in particular exceptionally well-preserved belemnites and pyritous ammonites. The Green Ammonite Beds are composed of a bluish grey micaceous many clay, with occasional nodules and bands of a hard grey limestone and ferruginous layers. The beds derive their name from the exquisite 'Green Ammonites' which are infilled with a green sparry calcite cement.

Although the provenance of many of the earlier fossil fish finds was inadequately documented (e.g. Egerton, *in* De la Beebe, 1839), fishes have been collected from the 'Saurian Shales' at the top of the Blue Lias (equivalent to Lang's Bed 52: *scipionianum* Subzone, *semicostatum* Zone, Early Sinemurian), from the Shales with Beef Beds (*semicostatum–turneri* Zones, Early Sinemurian; MacFadyen, 1970, p. 97), and from the '*Obtusum* Shale' of the Black Ven Marls (*obtusum* Zone, Late Sinemurian) (Woodward, 1886, 1889a, 1889b, 1891a, 1906; Rayner, 1958; (Figure 12.5)B)

The importance of Lyme Regis as a fossil fish locality is that the material is extremely well preserved (e.g. (Figure 12.6)A, I). Although scattered fish remains occur throughout the succession, the better-preserved material from the shale and marl units includes many whole, but laterally compressed specimens of bony fish, and impor- tandy a number of articulated partial chondrichthyan skeletons. It is for this reason that Lyme Regis is an essential reference for fish taxonomy.

Fauna

Based upon collections in the NHM, BRSMG and OUM and from references including Woodward (1886, 1889a, 1889b, 1891a, 1906), Duffin (1993b) and Duffin and Ward (1993b):

Chondrichthyes: Elasmobranchii: Euselachii: Hybodontoidea

Acrodus nobilis Agassiz, 1837 (includes material designated

A. *latus* Agassiz, 1839,

A. gibberulus Agassiz, 1839 and

A. *arietus* Quenstedt, 1858: Woodward, 1889)

A. *anningae* Agassiz, 1839

Lissodus sp.

?Hybodus cloacinus Quenstedt, 1858

H. raricostatus Agassiz, 1843

H. medius Agassiz, 1843

Chondrichthyes: Elasmobranchii: Neoselachii: Squalomorphii

'*Palaeospinax*' *priscus* (Agassiz, 1843) *nomen dubium*

Synechodus occultidens Duffin and Ward, 1993

S. enniskilleni Duffin and Ward, 1993

Chondrichthyes: Elasmobranchii: Neoselachii: Galeomorphii

Agaleus dorsetensis Duffin and Ward, 1983

Chondrichthyes: Holocephali: Chimaeriformes

Myriacanthus paradoxus Agassiz, 1836

Metopacanthus granulatus (Agassiz, 1837)

Recurvacanthus uniserialis Duffin, 1981

Squaloraja polyspondyla (Agassiz, 1836)

S. tenuispina Woodward, 1886

Osteichthyes: Actinopterygii

Centrolepis aspera Egerton, 1844

Coccolepis liassica A.S. Woodward, 1890

Cosmolepis ornatus Egerton, 1854

Platysiagum sclerocepbalum Egerton, 1872

Osteichthyes: Actinopterygii: Saurichthyiformes

Saurorhynchus (*Belonorhynchus*)*acutus* (Agassiz, 1844)

Belonorhynchus brevirostris (Woodward, 1895)

Osteichthyes: Actinopterygii: Chondrostei: Acipenseriformes

Cbondrosteus acipenseroides Egerton, 1858

C. pacbyurus Egerton, 1858

Osteichthyes: Actinopterygii: Holostei: Ptycholepidae

Ptycholepis gracilis Davis, 1884

P. curta Egerton, 1854–1855

P. monilifer Woodward, 1895

Osteichthyes: Actinopterygii: Neopterygii: Halecostomi

Dapedium politus (Leach, 1822)

D. (*Tetragonolepis*) *radiatus* (Agassiz, 1836–1844)

D. colei Agassiz, 1835

D. punctatum Agassiz, 1835

D. granulatum Agassiz, 1835

D. magnevillei Agassiz, 1833–1836 *nomen dubium*

Osteichthyes: Actinopterygii: Neopterygii: Halecomorphi

Caturus heterurus (Agassiz, 1839–1844)

C. latipennis (Egerton, 1858a)

C. (*Endactis*) *agassizi* (Egerton, 1858a) *nomen dubium*

C. (*Conodus*) *chirotes* (Agassiz, 1839)

Furo (*Eugnathus*) *orthostomus* Agassiz, 1842–1844

Furo (*E.*) *philpotœ* Agassiz, 1839–1844

Furo (*E.*) *minor* Agassiz, 1839

F. (*Lissolepis*) *serratus* (Davies, 1884)

F. altus A.S. Woodward, 1895

F. latimanus (Agassiz, 1838–1844)

Furo sp.

Heterolepidotus rhombiter Egerton, 1834–1835 (Agassiz, 1837)

Osteoarchis macrocephalus Egerton, 1868

O. (*Isoculum*)*granulatus* (Egerton, 1868)

Osteichthyes: Actinopterygii: Neopterygii: Teleostei

Pholidolepis dorsetensis Nybelin, 1966

Pholidophorus bechei Agassiz, 1844

P. pachysomus Egerton, 1852

P. caudalis Woodward, 1895

P. crenaluata Egerton, 1843

P. limbata Agassiz, 1833–1844

Pholidophoraspis maculata Nybelin, 1966

Pholidophoropsis sp.

Pholidophoroides sp.

Proleptolepis elongata Nybelin, 1974

P. furcata Nybelin, 1974

P. megalops Nybelin, 1974

Osteichthyes: Sarcopterygii: Actinistia

Holophagus (*Undina*) *gulo* Egerton, 1861

Interpretation

About 100 'new species' were described from Lyme Regis in the 19th century, when almost every new specimen was given a name. (According to our present taxonomic list, Lyme Regis has yielded type specimens of more than 50 species.)

Hybodont sharks are well represented, and specimens recovered in the 19th century included the lectotype of *Hybodus reticularis* (Agassiz, 1833–45; Woodward, 1916; Maisey, 1987a), which was regarded as the type species of the genus *Hybodus.* Five Lyme Regis species have been referred to this genus and these are all based upon good articulated material ((Figure 12.6)H). These species were reviewed by Woodward (1889a) and Duffin (1993b), who described the difficulties involved in trying to ascribe isolated *Hybodus* teeth from the Lower Lias succession of Britain and mainland Europe to their type species. Great difficulties have become apparent in distinguishing between four of the Lyme species, *H. reticularis, H. raricostatus, H. delabechii* and *H. cloacinus,* even though represented by articulated material (Woodward, 1889a). Heterodonty exists in these species, especially with respect to overall tooth dimensions, morphology and patterns of ornamentation. Duffin (1993b) considered it probable that there is some synonymy amongst the species. However, he considered the five Lyme *Hybodus* species valid and he provided means of distinguishing their isolated teeth. The five species of *Hybodus* all possess a heterodont dentition, with the predominantly 'clutching-type' teeth (Cappetta, 1987) of a piscivorous animal.

Acrodus and *Lissodus* are also represented in the Lower Lias hybodont shark fauna at Lyme Regis (Figure 12.6)I. Woodward (1889a) assigned two valid species, *A. anningae* and *A. nobilis* to the bottom-dwelling heterodont shark *Acrodus. Acrodus* is considered to have eaten fish, hard-shelled molluscs and crustacea (Cappetta, 1987).

Neoselachian sharks are also fairly well represented in the Lower Lias sequence of Lyme Regis (Thies, 1983). Duffin and Ward (1993b) have revised the taxonomy of the rather poorly known palaeospinacid sharks from Lyme Regis, and grouped the material into two species of a single genus, *Synechodus.* The palaeospinacids are considered to belong to the squalomorph neoselachians, and are probably a sister-group to the hexanchids (Cappetta, 1987; Duffin and Ward, 1993b). They are typically small sharks, up to 1 m long with a heterodont dentition. They possibly were slow-moving benthos, feeding on fish, molluscs and crustaceans in shallow waters (Thies, 1985).

Agaleus dorsetensis Duffin and Ward, 1983 was diagnosed on isolated teeth in the Blue Lias at Church Cliff, Lyme Regis. It is thought to have been an unspecialized swimmer with a benthonic habit, subsisting on hard-shelled molluscs and crustaceans, as well as fish (Duffin and Ward, 1983b). Thies and Reif (1985) suggested a similar lifestyle for the orectolobid sharks of the Callovian (Middle Jurassic) Oxford Clay.

The holocephalians are well-represented here by both squalorajids and myriacanthid chimaeroids. *Squaloraja polyspondyla* Agassiz is a small form (less than 0.6 m; Patterson, 1965), known from several partial skeletons. *Squaloraja* is the type and only genus of the squalorajid holocephalians, an enigmatic and seemingly primitive chimaeriform family. A second species of *Squaloraja* has been described from Lyme Regis, *S. tenuispina* Woodward, based upon a single front clasper.

Lyme Regis is the type and only locality for three species of myriacanthid, including the recently diagnosed *Recurvacanthus uniserialis* Duffin, named on a single isolated dorsal fin spine (Duffin, 1981). The other two genera were recovered from the Lower Lias succession in the 19th century and formed the basis for the diagnosis of the myriacanthid family of chimaeroids (Patterson, 1965). *Myriacanthus paradoxus* Agassiz is a large chimaeriform (over 1 m in length; Woodward, 1906; Patterson, 1965) described from articulated skull fragments and partial post-cranial remains (Woodward, 1891a). In contrast, the specimens of *Metopacanthus granulatus* (also 'known from partial skeletal remains) only reach 1 m, and the head is much less broad and flattened (Patterson, 1965). The type specimen of *Metopacanthus granulatus* was originally designated *Ischyodus orthorhinus* by Egerton (1871), but this was later corrected by Woodward (1889a, 1891a). Lower Lias myriacanthid chimaeroids are also known from France (Terquem, 1855), Holzmaden, Germany (Fraas, 1910), Hombois, Belgium (Duffin, 1980a), and Ostenso, Italy. Both sexes possessed a large frontal clasper. Squalorajids and myriacanthids are thought to have been largely bottom-dwellers with a durophagous diet.

Lyme Regis has yielded a fish fauna that seems to retain a rich contingent of primitive actinopterygians, including four type species plus a stem neopterygian (a saurichthyid), two species of chondrosteid acipenseriforms and a stem chondrostean. The primitive actinopterygians include the type and only species, *Centrolepis aspera* Egerton, known from three specimens collected at Lyme Regis. *Centrolepis* is a small form with a robust, somewhat elongated fusiform body covered in thick and highly ornamented scales (Woodward, 1890). *Coccolepis liassica* Woodward is also known only from Lyme Regis. It, too, is a small fish (up to 0.14 m long; (Figure 12.6)F but clad in thin scales ornamented with irregularly arranged tubercles. This species has a large head and typical dentition of inner large conical teeth, flanked externally by minute slender teeth (Woodward, 1891a). *Oxygnathus* (also known as *Cosmolepis*) and *Platysiagum* complete the list of these rather similar primitive taxa from Lyme Regis.

The Lyme Regis chondrostean assemblage also includes the type specimen of the large saurichthyid species *Saurorhynchus* (*Belonorhynchus*) *brevirostris* (Woodward), also known from the Upper Lias of Whitby (q.v.) and Holzmaden, Germany (Reis, 1892; Woodward, 1895a). The species possessed a typically long, slender, tubular body and small head with pointed elongated mandible lined with sharp, well-spaced conical teeth (Gardiner, 1967). The acipenseriform chondrosteans *Chondrosteus acipenseroides* Egerton (Figure 12.6)C and *C. pachyurus* were also described from the Lower Lias of Lyme Regis. *Chondrosteus acipenseroides is* the type species and is known from several complete specimens collected from Dorset and Barrow-on-Soar, Leicestershire, in the 19th century (Woodward, 1895a), whilst *C. pachyurus* is only known from three imperfect specimens from Lyme Regis (Egerton, 1858b). *Chondrosteus* is large robust chondrosteid with a strongly heterocercal tail. The specimens commonly do not exceed a length of 1 m and both species possessed a well-developed headshield, weakly ornamented with ganoine-coated granulations. The jaws unusually lack a dentition and ribs are absent (Woodward, 1895a). *Chondrosteus* is also known from Upper Lias of Holzmaden, Germany (Frickhinger, 1991).

Halecostomid actinopterygians are represented in the Lower Lias of Lyme Regis by the deep-bodied semionotid genus *Dapedium.* Six species of *Dapedium* are known from this locality including the type species, *D. politus* (Leach, 1822; (Figure 12.6)A, A'). *Dapedium* is a moderately large fish, ranging from 0.3 to 0.6 m in length and with a rounded laterally flattened trunk, with tiny paired fins and dorsal and anal fins that extend from the mid part of the body to the base of the tail (Woodward, 1895a). The head was comparatively small with a highly differentiated dentition of robust, styliform teeth, some bicuspate. The bones of the head were usually ornamented with bumps coated in ganoine and the trunk scales were often ornamented with fine tubercles (Woodward, 1895a). *Dapedium* is a widespread genus, which extends from the Upper Triassic to Upper Lias in Europe (Frickhinger, 1991). Several more species (e.g. *D. orbis, D. dorsalis* and *D. angulifer*) have been described from Lower Lias successions in England, and many of the Lyme Regis species have been found in the Upper Lias of Europe (Woodward, 1895a; Wenz, 1967).

Caturids are most abundant at Lyme Regis and five genera (*Caturus, Furo, Heterolepidotus, Ptycholepis* and *Osteorachis*)have been described from the site. Different species and genera of caturids are essentially subdivided on the morphology and ornamentation of the head bones, and slight differences in the postcranial skeleton (Woodward, 1895a). The type genus, *Caturus,* possesses the general form, size and osteology typical of most of the genera listed here.

In the British Lower Liassic actinopterygian fish faunas two distinct levels of development were discernible: the halecostomid as exemplified by the semionotids such as *Dapedium,* and the halecomorphs such as *Caturus.* Both were predaceous fish, and in *Dapedium* the old conservative structure of the mouth and jaw mechanism persists. Here the cranial parts of the head were rigid, fully ossified, and there was a limited extent to the expansion of the mouth cavity. The fish could not make a sudden large intake of water. To catch prey speed was essential, yet the ability for fast acceleration was limited by the shape and position of the fins. In the caturids the new structure of the mouth parts and the mobility of the braincase increased suction power to the point where it aided seizure of prey, and improvements in body and fin kinetics led to an ability to seize many kinds of prey more effectively. This tendency was to be further developed amongst the teleosts.

Primitive teleosts, including eight type species, have also been recorded from the Lyme Regis cliffs (Figure 12.6), and include some of the earliest representatives of the pholiphorids and leptolepids (Nybelin, 1966, 1974b). They show several features of the skull, jaws and weakly ossified vertebrae seen in all late Mesozoic teleosts, despite retaining ganoid scales. They were large voracious feeders growing to 60 cm in length.

Holophagus gulo Egerton, a large (0.7 m length) coelacanth genus, has been described from the Lower Lias at Lyme Regis ((Figure 12.6)E). Indeed, Lyme Regis is the type and only locality for this rare Jurassic actinistian fish, although isolated coelacanth material has been recorded from the Lower Lias at Barrow-on-Soar, Leicestershire (Woodward, 1891a) and a second species (*H. penicillata*)is known from the Upper Kimmeridgian of Germany. *Holophagus* is a stout-bodied, robust form, with a large, externally ornamented headshield and scales (Woodward, 1891a).

Lyme Regis has also yielded type specimens of 14 species of reptiles, nine of which only occur there. The majority of the reptiles are the fish-eating marine forms, plesiosaurs and ichthyosaurs, but include a piscivorous pterosaur.

Comparison with other localities

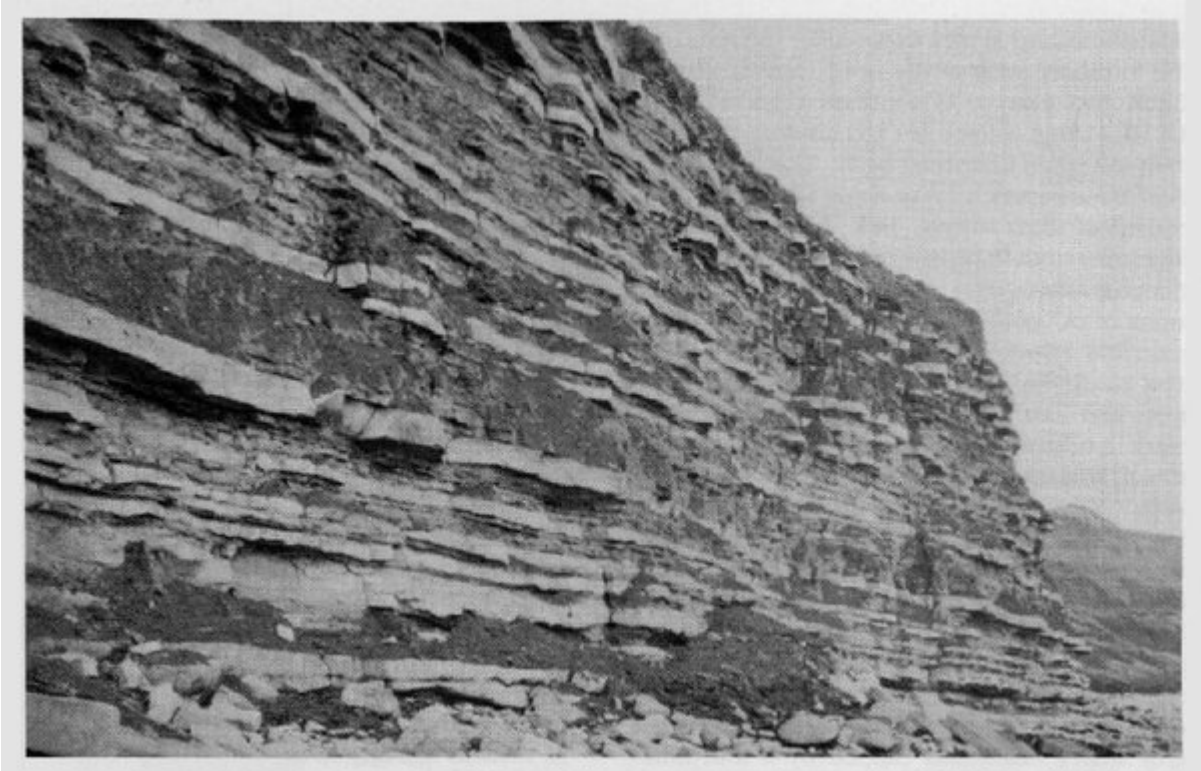
The fauna recovered from the Lower Lias succession at Lyme Regis is unique in being so diverse and well preserved. A similar shark fauna has recently been recovered from the Lower Lias of Blockley Station Quarry (q.v.) and bony fish specimens were frequently recovered from the old brick pits at Barrow-on-Soar, Leicestershire; Barnstone, Nottinghamshire; and Street in Somerset (all Lower Hettangian; Hallam, 1968). Like those of Lyme Regis, their fossil fishes are similarly well preserved and have yielded some type material (Woodward, 1891a, 1901). The assemblages from Barrow-on-Soar have been particularly well studied (Brodie, 1857a, 1857b; Browne, 1889a; Fox-Strangways, 1903; Gardiner, 1960) and many species of fish and reptile show evidence of soft tissue preservation (Martin *et al.,* 1986, and references therein). The same faunas were recovered from Barnstone in the 1930s: Kent (1937) considered the palaeoenvironment of the Lower Lias in the English Midlands to be nearshore marine, because of the abundance of insect and plant material in the sections at Barnstone and Barrow. However, all but a very few of the pits there are now infilled and no new finds have been recorded.

There is a rather scattered record of fish faunas of this age throughout the world, but mostly they occur in north-western Europe, Lombardy in Italy and in the south-western states of the USA as well as in the Newark Group of the American northeast (Schaeffer and Patterson, 1984). Elsewhere Lower Jurassic fishes are known in the Caribbean, Brazil and southeast Asia (Arratia and Viohl, 1995).

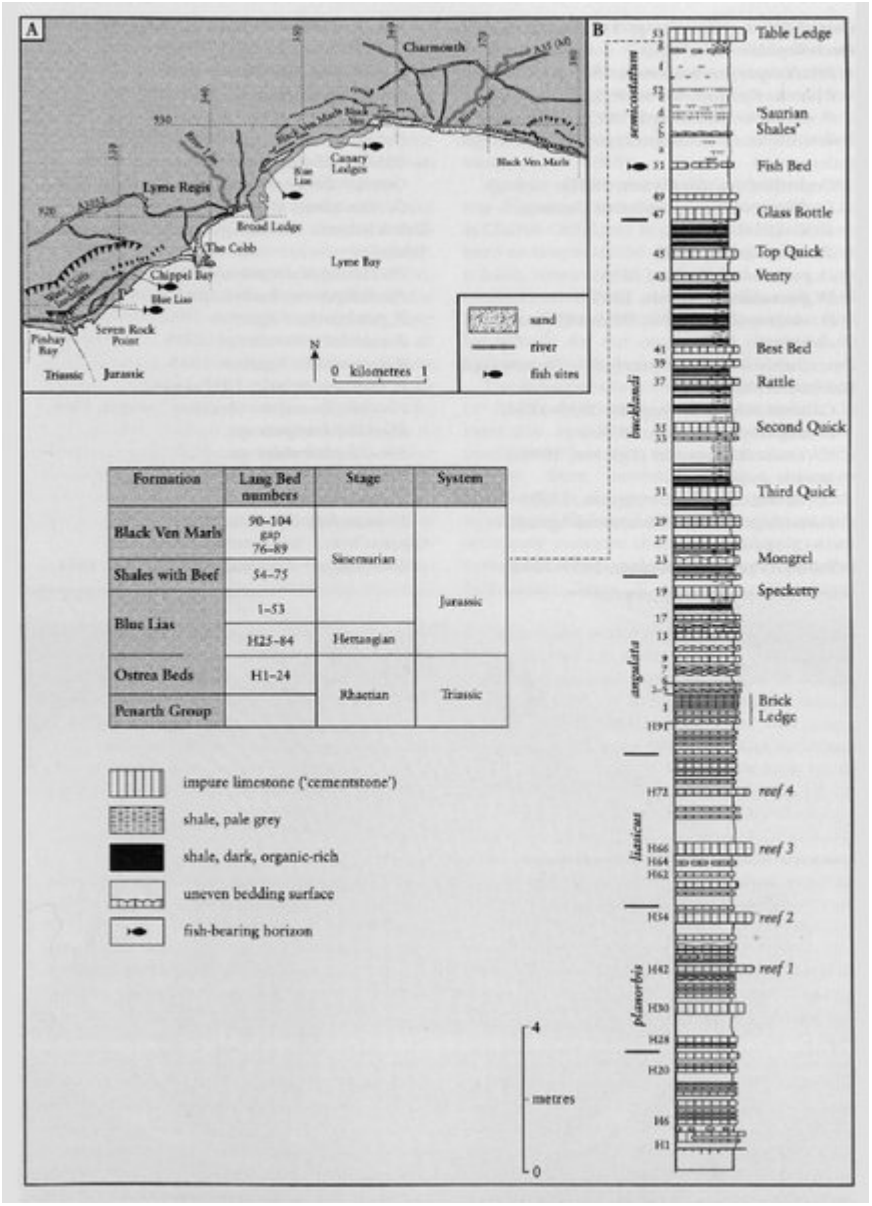
Conclusion

The Lyme Regis coast section of Lower Lias is one of the most important fish-bearing sites in Britain and has an internationally recognized status, hence its conservation value. It has yielded many type specimens, the remains of which are extremely well preserved, it still yields whole fish, and the only comparable site of the same age outside Britain is Ostenso, Italy. Historically, Lyme Regis is unique, and its potential for future finds is excellent.

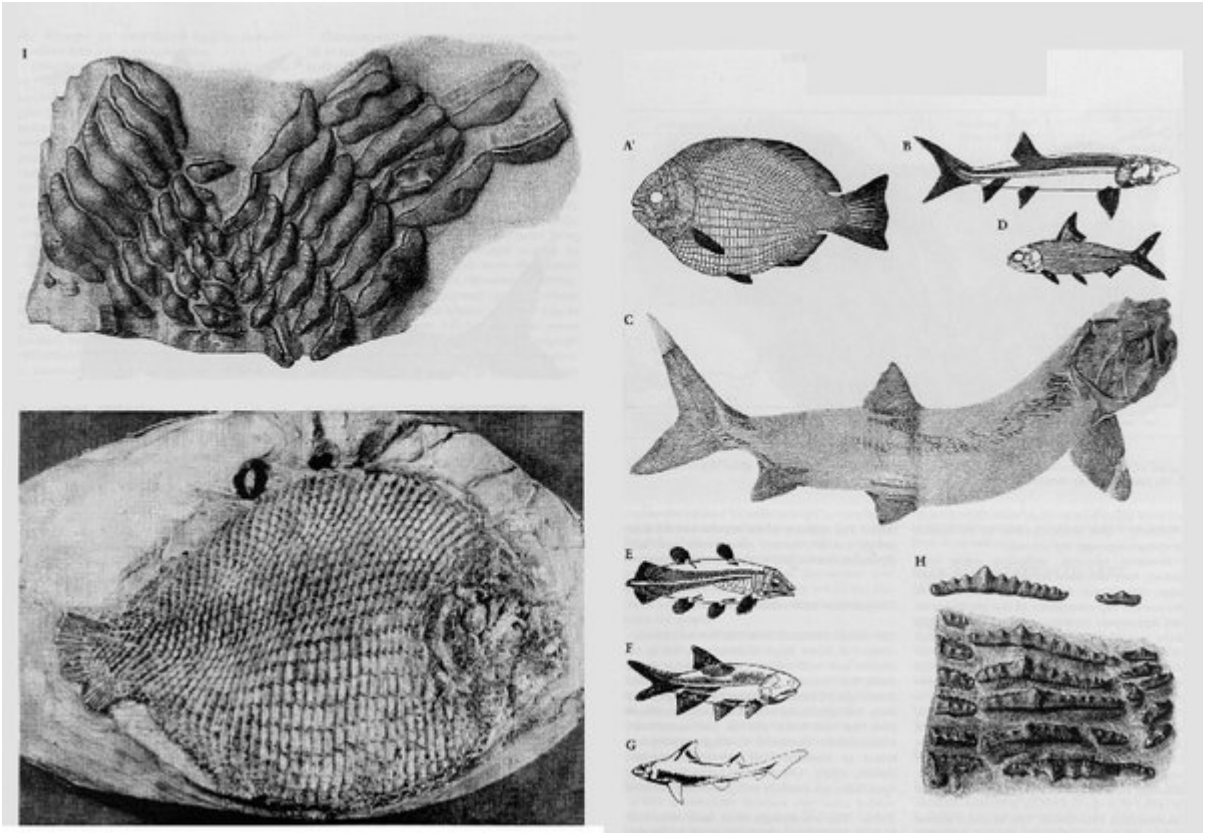
References



(Figure 12.4) The Lower Liassic shales and cementstones in Ware Cliffs, north-west of Lyme Regis harbour (photo: G.W Storrs).



(Figure 12.5) (A) Map of the coastal outcrop of the Lower Lias, Charmouth to Lyme Regis (after Benton and Spencer, 1995); (B) rock succession (after House, 1993).



(Figure 12.6) Liassic fishes from Lyme Regis: (A), Dapedium politus (Leach), x 0.5 (Photo: courtesy The Natural History Museum, London, T00144/A). Liassic fishes from Lyme Regis: (AI) (restoration), Dapedium politus x 0.2; (13) Chondrosteus acipenseriodes Egerton, x 0.1, restoration by Woodward (1895); (C) Chondrosteus aeipenseroides (Egerton) skeleton and body outline preserved, x 0.2; (D) the teleostPholidophorus sp., x 0.1, restoration by Woodward (1895); (E) the coelacanth Holophagus gulo Egerton, x 0.25, restoration by Woodward (1895); (F) the palaeoniscoid Coccolepis bucklandi Agassiz, x 0.5; (G) the elasmobranch Hybodus, x 0.1, restoration by Maisey (1982); (H) teeth of the elasmobranch Hybodus, isolated individual teeth and part of the dental array, x 1.0. Figures from Woodward (1889–1901) *(Continued on p. 368.)* *(Figure 12.6) — contd. Liassic fishes from Lyme Regis: (I) array of Acrodus teeth, x 1.0 (from Woodward, 1895,*